EFFEC OF SALT STRESS ON YIELD AND ITS COMPONENTS OF FOUR CULTIVARS OF BARLER

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ABSTRACT

A field experiment was carried out at the field with clay loam soil in the winter seasons of 2018 - 2019 and 2019 - 2020 in order to study the effect of three levels of salt stress on yield and its components for four cultivars of barley (*Hordeum valgare* L.). which be approved in Iraq.Factorial experiment with in Randomized Complete Block design with three replications. The treatments included three levels of irrigation water salinity (5,10,15) ds.m^{-1} and four cultivars of barley (IPA 99, Buhooth 265, Samir, and Amal). The results showed that the salinity of the irrigation water caused a significant decreases of the number of spikes.m^{-2}, number of grains. spike^{-1}, weight of 1000 grains (gm) and grain yield. plant^{-1} at levels S2 and S3 and for both studies seasons in comparison with treatment S1, which gave the highest averages for the mentioned traits, significant differences among barley cultivars in terms of their tolerance to salinity. It was found that Samir cultivar was more tolerant to salinity than the other cultivars.

Key words: grain yield, weight of 1000 grains, plant height, biological yield.

تأثير الاجهاد الملحي على الحاصل ومكوناته لأربعة اصناف من الشعير

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المستخلص

نفذت تجربة حقلية في تربة ذات نسجه طينية مزيجه في الموسمين الشتويين لعام 2018- 2019 و2019- 2020 بهدف دراسة تأثير ثلاث مستويات من الاجهاد الملحي على الحاصل ومكوناته لأربعة اصناف من الشعير المعتمدة في العراق. استعمل تصميم القطاعات الكاملة المعشاة وبترتيب عاملي وبثلاثة مكررات، تضمنت معاملات التجربة ثلاثة مستويات لملوحة ماء الري (5،10،15) ds.m^{-1} وأربعة اصناف من الشعير(اباء 99، بحوث 265، سمير و أمل). أظهرت النتائج ان ملوحة مياه الري سببت انخفاضا معنويا في عدد السنابل.م$^{-2}$، عدد الحبوب.سنبلة$^{-1}$ ،وزن 1000 حبة (غم) وحاصل الحبوب .نبات.$^{-1}$ عند المستويين S_2 وS_3 ولموسمي الدراسة بالمقارنة مع المعاملة S_1 التي اعطت اعلى المتوسطات للصفات المذكورة، كما كانت هناك اختلافات بين اصناف الشعير من حيث تحملهما للملوحة، فقد تبين ان الصنف سمير كان الاكثر تحملا للملوحة عن باقي الاصناف.

الكلمات المفتاحية: حاصل الحبوب، وزن 1000 حبة، ارتفاع النبات، الحاصل البايولوجي

Received:15/1/2021, Accepted:10/4/2021

INTRODUCTION

Iraq Agriculture influenced by different problems, including the scarcity of fresh water from its sources. The most important of these impacts is to search for alternatives of water sources, including the use of saline water for irrigation despite the negative effects that these processes cause on the properties of the soil and the components of the yield. One of the most serious issues is the salinity of irrigation water. As the presence of salts in the soil or irrigation water both affects the growth of crops by reducing the moisture available to plants as a result of the osmotic pressure of the soil solution, which leads to an imbalance in the nutritional balance of plants (7, 8). The difference of barley cultivars (*Hordeum vulgare* L.) in their level of salt tolerance resultant from genetic differences in the control of ion uptake and carrying in xylem (2). Also, obtaining high tolerance genotypes is one of the priorities for this problem. The economic importance of the barley crop as it is an important fodder crop in feeding ruminants in addition to its uses in human nutrition and for industrial purposes, but the cultivated area of this crop is still low and the yield per unit area is still low as a result of salinization of some agricultural soils. Therefore, it has become important to study all available means for the purpose of reducing the effects of salinity. Several studies were conducted by researchers to assess the level of salt tolerance of different crop varieties to reach the most tolerant genotypes (4, 6 ,9). The purpose of this study was to look into the effects of varying salt levels on different barley cultivars in Iraq's central area

MATERIALS AND METHODS

A field experiment was conducted in the Abu Ghraib research fields in Baghdad to investigate the effect of three degrees of irrigation water salinity on the productivity of four certified barley cultivars in Iraq over two seasons, 2018-2019 and 2019-2020. Before starting the experiment, samples were taken from the soil profile, at a depth of (0-30) cm. The chemical and physical properties of it were studied according to the standard methods of Black *et al*. (7) as shows in table (1). The experimental land was plowed, prepared and divided into plots according to the treatments to represent the experimental units. The experiment comprised three degrees of irrigation water salinity, which are S1, S2, and S3 (5,10,15) $ds.m^{-1}$, respectively, and four cultivars of barley, namely (IPA 99, Buhooth 265, Samir and Amal). Randomized Complete Block Design with, three replicates was used, Planting was completed on November 26th for both seasons in plots (6 m^2) on lines with a 20 cm spacing between lines, using a seeding rate of 120 kg. ha^{-1}. The experimental units were irrigated with fresh water when planting, then irrigated with saline water according to salinity levels. At planting, triple super phosphate fertilizer was applied at a rate of 100 kg $P_2O_5.ha^{-1}$(46%) (P_2O_5) and potassium sulphate fertilizer was applied at a rate of 80 kg $K_2O.h^{-1}$, while urea fertilizer (N46 %) was applied in four splits at a rate of 200 kg ha^{-1} (at planting, when three full leaves appeared, when the second node appeared on the main stem and at the booting stage) according to the Zodoks scale (22) and FAO(9). Growth characters and production were recorded for two seasons, including plant height, the amount of spikes. m^{-2} is the number of grains. $spike^{-1}$, 1000 grain weight (gm), and grain yield $Plant^{-1}$. The data were statistically analyzed independently for each season and according to the design, and the least significant difference(LSD) test was employed to compare the means of the researched features at the 0.05 probability level.

Table 1. shows the chemical and physical properties of field soil

Character	2018	2019
pH	7.5	7.3
CEC	5.6	5.1
Avail. N mg kg^{-1}	154	159
Avail. P mg kg^{-1}	16.7	18.82
Avail. K mg kg^{-1}	364	406
O.M	0.731	0.964
Soil components		
Bulk density $Mg.m^{-3}$	1.31	1.31
Sand mg. kg^{-1}soil	219	341
Silt mg. kg^{-1}soil	465	446
Clay mg. kg^{-1}soil	316	213
Soil texture	Silty clay	Silty clay

RESULTS AND DISCUSSION

Plant height (cm): The results indicate a significant effect of irrigation water salinity levels on plant height (Table 2), as the average plant height decreased at salinity level S3 and reached (76.10 and 67.88 cm) compared to salinity level S1, which achieved the highest plant height of (95.38 and 84.36 cm). for two years Plant height may have decreased due to an increase in the concentration of salty components in the soil solution, which increases the rate of permeability of elements into root cells, which increases their toxicity and inhibitory effect on the course of metabolic and structural processes, and the property of cell division and elongation that affects plant growth. The concentration of salts in the growth medium also affects the absorption of a greater amount of harmful chlorine Cl^{-1} and Na^{+} ions, and their accumulation at toxic levels in plant tissues, as it works to inhibit the division and elongation of cells of growing plant tissues. There were also considerable variations in plant height amongst the barley varieties cultivated in the second season, as the cultivar Amal gave the highest average plant height of 78.09 cm in comparison to the cultivar Buhooth 265, which gave the lowest average of 74.08 cm (3). For the two seasons, the interaction between cultivars and salt levels had no significant influence on plant height. (1, 6, 13, 20).

Table 2. Effect of salt stress on plant height (cm) of barley cultivars grown for the 2018- 2019 and 2019 – 2020 seasons

Cultivar	Salinity levels $ds.m^{-1}$ (2018)			Means
	S1	S2	S3	
IPA 99	95.63	85.63	76.60	85.96
Buhooth 265	95.63	85.70	76.70	86.11
Samir	93.83	84.47	74.60	84.30
Amal	96.13	86.70	76.50	86.33
LSD		N. S		N. S
Means	95.38	85.62	76.10	
LSD		2.034**		
		2019		
Cultivar	Salinity levels $ds.m^{-1}$			Means
	S1	S2	S3	
IPA 99	84.97	76.13	70.23	77.11
Buhooth 265	80.67	75.50	66.07	74.08
Samir	83.97	73.47	65.37	74.27
Amal	87.83	76.60	69.83	78.09
LSD		1.485**		1.714**
Means	84.36	67.88	75.89	
LSD		2.012**		

Number of spikes m^{-2}

The results show that there are significant variations between salinity levels barley cultivars, as well as their interaction in the number of spike.m^{-2} in the two seasons (Table 3). Salinity levels led to a significant decrease in the average number of spikes.m^{-2} at level S3, which amounted to (288.8 and 292.4) compared to salinity level S1, which gave the highest average of spikes.m^{-2} (347.8 and 366.0) for both seasons respectively. These results agree with El-Saadawi and Dahesh (8), they showed that the decreases in the number of spikes.m^{-2} , occurs as a result of an increases in salinity, which affects the efficiency of the photosynthesis process, cell division and its response to environmental conditions. The results also indicate the superiority of the barley cultivar Samir in giving the highest average number of spikes.m^{-2} (331.9 and 341.1) for both seasons. As for the cultivar Buhooth 265, which had the lowest average number of spikes.m^{-2} (308.0 spikes.m^{-2}) for the first season. The tolerance of some cultivars to salinity levels could be due to their mechanisms that enable them to maintain the ionic balance inside the plant and the ability to exclude harmful saline elements, especially sodium, and then maintain the absorption of beneficial elements such as potassium. The salt-tolerant genotypes are able to exclude sodium to less effective areas and reduce its absorption, especially alkaline damage (12, 21). The results also indicate that there is significant interaction between barley cultivars and salinity levels. As there was a significant decrease in spikes.m^{-2} for Amal barley cultivar at saline level S3 for the two seasons respectively, it amounted to (301.1 and 313.9) spikes.m^{-2} respectively, while saline level S1 produced the highest average number of spikes for barley cultivar Samir which had (375 and 374) spikes. m^{-2} for the two terms, respectively. Therefore; such a decrease in this characteristic could be attributed to the increase in the concentration of salts in the soil solution and the high death rate of the formed vegetative tillers and the failure of these tillers to transform into tillers bearing spikes, a decrease in the leaf area and a lack of manufactured photosynthetic products necessary for the growth and development of the formed tillers.

Table 3. Effect of salt stress on number of spikes m^{-2} of barley cultivars grown for the 2018-2019 and 2019 – 2020 seasons

Cultivar		2018 Salinity levels ds.m^{-1}		Means
	S1	S2	S3	
IPA 99	365.0	305.0	290.7	320.2
Buhooth 265	332.3	302.3	289.3	308.0
Samir	375.0	325.8	295.0	331.9
Amal	319.0	304.0	280.3	301.1
LSD		11.01		6.36
Means	347.8	309.3	288.8	
LSD		5.50		
Cultivar		2019 Salinity levels ds.m^{-1}		Means
	S1	S2	S3	
IPA 99	365.0	340.0	294.7	333.2
Buhooth 265	370.0	319.0	280.3	324.8
Samir	374.0	334.3	319.0	341.1
Amal	354.0	312.0	275.7	313.9
LSD		11.09		6.41
Means	366.0	326.3	292.4	
LSD		5.55		

Number of grains spike^{-1}

The results in table (4) indicate that there are extremely significant changes in the quantity of grains between salt levels and barley cultivars, as well as their interaction. spike^{-1} (Table 4). The salinity level S1 recorded the highest average number of grains. spike^{-1} (47.42 and 47.72) for the two seasons respectively compared to the salinity level S3 which gave the lowest number of grains. spike^{-1} (30.92 and 31.28) for the two seasons, respectively (12,21). The results also showed the superiority of the barley cultivar Samir in the average number of grains. spike^{-1} (41.29 and 41.47) during the two seasons, whereas the cultivar Buhooth 265 gave the lowest level of (36.70 and 37.26) grains. spike^{-1} for the two seasons, respectively. This differential might be attributed to genetic variations between cultivated barley types as well as a decrease in effective leaf area throughout the photosynthesis process, thus reducing the light energy absorbed and converted into stored chemical energy, which leads to an increases in the percentage of aborted florets, thus reducing the number of grains. spike^{-1} in addition to the insufficiency of the manufactured material during the pre-flowering stage (Al-Saadawi and Dahesh, 2000). In terms of the impact of the interaction of cultivars and salt levels, the cultivar Amal produced the highest level of this characteristic (50.17 and 50.17) grains. spike^{-1} at the level of salinity S1. concerning the cultivar Buhooth 265,it has produced the lowest average number of grains. spike^{-1} for the first season (29.57 grains. spike^{-1}). The reason for this could be due to it's mechanisms that enable it to maintain the ionic balance inside the plant and the ability to exclude harmful salt elements and then preserve the beneficial elements such as potassium, and this will be reflected in the good performance of the crop growth and increases the yield (6).

Table 4. Effect of salt stress on number of grains. spikes^{-1} of barley cultivars grown for the 2018- 2019 and 2019 -2020 seasons

Cultivar	2018 Salinity levels ds.m^{-1}			Means
	S1	S2	S3	
IPA 99	45.97	37.73	30.53	38.08
Buhooth 265	44.97	35.57	29.57	36.70
Samir	48.57	41.93	33.37	41.29
Amal	50.17	38.27	30.20	39.55
LSD		2.429		1.403
Means	47.42	38.38	30.92	
LSD		1.215		
Cultivar	2019 Salinity levels ds.m^{-1}			Means
	S1	S2	S3	
IPA 99	45.90	37.73	30.40	38.01
Buhooth 265	44.97	35.43	31.37	37.26
Samir	49.83	41.33	33.27	41.47
Amal	50.17	40.05	30.07	40.09
LSD		1.962		1.133
Means	47.72	38.64	31.28	
LSD		0.981		

Weight of 1000 grains (gm):

The results intable (5) indicate a significant effect of salinity levels to the weight of 1000 grains, as the averages decreased significantly at levels S3 and S2, and the lowest value at level S3 was (37.11 and 34.77) gm, while level S1 produced the highest average weight of 1000 grains (41.76, 40.01) gm for each season, This may be attributed to an increase in dissolved salt content in the soil solution, which led to a decrease in the amount of water available to the plant during the stage of grain filling due to the increase in the rate of water loss by evapo-transpiration as a result of the high temperature of the surrounding environment and the decrease in the amount of water absorbed by the roots due to the decrease in the value of the water potential due to the presence of an excessive amount of dissolved salts in the soil solution, where these salts reduced the gradient differences in the water potential between the soil and the plant, causing a decrease in the amount of water flowing and absorbed by the roots, This has a detrimental impact on photosynthetic product decrease from the sources to the sink (grain), A negative impact on grain filling and weight of 1000 grains is caused by the principal transporter, water. For a typical weight of 1000 grains(gm), the cultivars differed considerably in how much they were impacted by the salinity of the irrigation water. For two seasons, the cultivar Amal had the lowest average for the trait (38.72, 36.98) gm compared to the cultivar Samir, which had the greatest rate for the trait (40.80, 38.94) gm. The variance in cultivar responses to irrigation water salinity may be related to genetic heterogeneity in their responses to irrigation water salt, as a result of which (1, 5, 16). There was a significant influence of irrigation salinity levels on 1000 grain weight with Amal at level S3 showing the lowest average 1000 grain weight (36.17, 33.30)gm, whereas the barley cultivar Samir had the highest rate of the characteristic at salinity S1 (44.67, 41.03) gm for both seasons. This could be attributed to the cultivar differences according to their genetic structure their ability to invest in growth factors and the food that is available for the grain from the source (leaf) during the fertilization stage to the stage of physiological maturity (1).

Table 5. Effect of salt stress on weight of 1000 grains (gm) of barley cultivars grown for the 2018- 2019 and 2019 -2020 seasons

		2018		
Cultivar		**Salinity levels ds.m^{-1}**		**Means**
	S1	**S2**	**S3**	
IPA 99	**40.37**	**39.17**	**37.57**	**39.03**
Buhooth 265	**40.67**	**39.73**	**36.90**	**39.10**
Samir	**44.67**	**39.93**	**37.80**	**40.80**
Amal	**41.33**	**38.67**	**36.17**	**38.72**
LSD		**1.041**		**0.701**
Means	**41.76**	**39.38**	**37.11**	
LSD		**0.520**		
		2019		
Cultivar		**Salinity levels ds.m^{-1}**		**Means**
	S1	**S2**	**S3**	
IPA 99	**39.33**	**37.43**	**35.63**	**37.47**
Buhooth 265	**39.00**	**39.43**	**33.73**	**37.39**
Samir	**41.03**	**39.37**	**36.43**	**38.94**
Amal	**40.67**	**36.97**	**33.30**	**36.98**
LSD		**1.467**		**0.848**
Means	**40.01**	**38.30**	**34.77**	
LSD		**0.734**		

Grain yield (gm. plant^{-1})

Table (6) shows significant differences between salt levels, barley cultivars, and their interaction during the two seasons (Table 6). The average yield decreased significantly at salinity level S3 and reached (712.3 and 573.8) compared to salinity level S1 which produced (947.1 and 912.3) gm. plant^{-1} during the duration of the two seasons. This could be attributed to the stress to the plants exposed during the stages in which the growth of both the flag leaf and the spike holder and the formation of florets in the spike are accompanied by an increase in competition for the products of photosynthesis. As a result, the fertilized florets are unable to obtain the full nutritional requirements, and could be lead to the death of a large proportion of the tillers formed later as a result of the increased salinity of the irrigation water. This result is in agreement with (11, 12, 17, 18, 19). The data also indicated substantial disparities in barley cultivar averages for both seasons. Samir, a barley variety, achieved the highest average grain yield (899.8 and 763.2) gm, compared with other cultivars, due to superiority of it is distinction in some components of the yield, including the number of spikes. plant^{-1}, weight of 1000 grains, this can be attributed to the genetic variation between barley cultivars, as well as to environmental differences, including the salinity of irrigation water and soil (Zein *et al.* 2002), and these results are the same as what was found (10). The effect of the interaction between salinity levels and barley cultivars was evident in the salinity tolerance of barley cultivars The effect of the interaction between salt levels and barley cultivars was visible in the salinity tolerance. It was noticed that the cultivar Samir achieved had highest mean of the trait at the salinity level S2, which reached (913.4 and 718.4) gm. plant^{-1} for both season. The tolerance of the variety to salinity may be due to its adaptation to saliently, in addition to the fact that it possesses special mechanisms that enable it to withstand salinity levels, such as excluding the element of sodium in the roots or lower parts of the plant and preventing it from moving to the biologically active upper parts, this is one of the important mechanisms of salinity tolerance and could be taken as evidence for selection for this characteristic. As the increase in the concentration of the sodium element in the active parts, especially. The upper parts of the plant, causes a weakening of vital processes, especially photosynthesis, and a decrease in the percentage of chlorophyll in the green parts, in addition to accelerating their aging (19). Also, the high concentration of potassium in the upper parts at the expense of sodium leads to an increase in the value of the ratio of potassium to sodium, and this is one of the important and effective issues in salinity tolerance mechanisms (11,14, 15).

Table 6. Effect of salt stress on Grain yield (gm. plant^{-1}) of barley cultivars grown for the 2018- 2019 and 2019 -2020 seasons

Cultivar		2018 Salinity levels ds.m^{-1}		Means
	S1	S2	S3	
IPA 99	882.1	864.1	723.7	823.3
Buhooth 265	859.5	774.2	691.1	774.9
Samir	1042.8	913.4	743.2	899.8
Amal	1004.0	755.4	691.4	817.0
LSD		75.49		43.58
Means	947.1	826.8	712.3	
LSD		37.74		
Cultivar		2019 Salinity levels ds.m^{-1}		Means
	S1	S2	S3	
IPA 99	906.9	710.8	562.3	726.7
Buhooth 265	829.2	657.2	560.7	682.3
Samir	984.0	718.4	587.3	763.2
Amal	928.9	668.0	584.8	727.2
LSD		59.27		34.22
Means	912.3	688.6	573.8	
LSD		29.63		

CONCLUSION

We conclude from the above that the barley cultivar Samir was more tolerant of salinity levels, its productivity at S2 salinity level was better than the other cultivars.

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