Response of some barley cultivars to drought tolerance by the effect of proline spraying and its reflection on the traits of growth and yield

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Abstract

This study was conducted during the winter season (2019-2020) at the Agricultural Research and Experiments Station belonged to the College of Agriculture ,the University of Kirkuk Al Sayada location. The study included two experiments (Rainfed agriculture and sprinkler irrigation) to knowing the effect of spraying with proline on drought tolerance for growth and productivity indicators of barley cultivars (*Hordeum vulgare*),The experiment was conducted according to the Randomized Complete Block Design (RCBD) and by arranging the split-plot with three replicates. The experiment was conducted separately from the other. The main plots included proline at two levels (0 and 0.750) $g.L^{-1}$,While (six) cultivars (Buraq, Samir, Al-Khair, Al-Hatra, Iksad and Amal) were placed in the sub-plots. Field traits were measured during the vegetative growth period, yield and its components. The results of the study are summarized as follows: The cultivars varied in most of the traits, where the Amal cultivar excelled in the traits of average relative growth and the Samir cultivar in the trait of harvest index. While the Amal cultivar excelled in the quality of the grain yield, as it reached (3930.6 $\mu g.ha^{-1}$), and in the trait of average drought tolerance with an average of (0.838), While the Iksad cultivar excelled in the weight of the 1000 grains, reaching (34.943 g), and the , Al-Khair cultivar excelled on protein percentage (14.150%).The mean of the squares of spraying with proline showed a significant effect for most of the traits, including the grain yield trait (3442.4 $\mu g.ha^{-1}$), the harvest index (33,529), the protein percentage (14.091%) and the drought tolerance (0.756).There was a significant difference between the two experiments in the trait, where the spraying experiment showed its excelled on the trait , including the grain yield (38699 $\mu g.ha^{-1}$) and the weight of 1000 grains, which reached (30.724 g).Whereas, the Rainfed agriculture experiment was excelled on the average relative growth (0.016 g/ g/ day), harvest index (33.394) and protein percentage (13.844%), and there was a significant difference between the two experiment in the traits.

Key words: barley cultivars, proline spraying , Qualities traits.

استجابة بعض أصناف الشعير لتحمل الجفاف بتأثير رش البرولين وانعكاسه في صفات النمو والحاصل

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المستخلص

أجريت هذه االدراسة خلال الموسم الشتوي (2019 - 2020) في محطة البحوث والتجارب الزراعية العائدة لكلية الزراعة في جامعة كركوك موقع الصيادة وتضمنت الدراسة تجربتين (الديم و الري بالرش) - لمعرفة تأثير الرش بالبرولين على تحمل الجفاف لمؤشرات النمو والانتاجية لأصناف من الشعير ***Hordeum vulgare L.*** ، أستعمل تصميم الألواح المنشقة – split plot وتم ترتيب المعاملات وفق القطاعات العشوائية الكاملة (R.C.B.D) وبثلاث مكررات وتم تنفيذ التجربة بشكل منفصل الواحدة عن الأخرى . تضمنت القطع الرئيسية (main plots) مستويات رش ورقي على النبات بالبرولين وبمستويين (0 و 0.750) غم. لتر$^{-1}$ ، فيما وضعت (ستة) أصناف

وهي (براق و سمير و الخير و الحضر و أكساد و أمل) في القطع الثانوية (sub- plots) . وتم قياس الصفات الحقلية خلال فترة النمو الخضري والحاصل ومكوناته. تلخصت نتائج الدراسة بالآتي:

تباينت الأصناف في معظم الصفات اذ تفوق الصنف امل في صفة متوسط النمو النسبي وتفوق الصنف سمير في صفة دليل الحصاد فيما تفوق الصنف أمل في صفة حاصل الحبوب اذ بلغ (3930.6 ميكاغرام. ه$^{-1}$) وفي صفة متوسط تحمل الجفاف بمتوسط (0.838) ، بينما تفوق الصنف اكساد في صفة وزن الف حبة اذ بلغ (34.943 غم) و تفوق صنف الخير في النسبة المئوية للبروتين (14.150 %) .وأظهر متوسط المربعات للرش بالبرولين تأثير معنوي لمعظم الصفات منها وصفة حاصل الحبوب (3442.4 ميكاغرام. ه$^{-1}$) ودليل الحصاد (33.529) ونسبة البروتين (14.091%) وفي صفة تحمل الجفاف اذ بلغ (0.756) .وكان هناك فرق معنوي بين التجربتين في الصفات أذ بينت تجربة الرش تفوقها في الصفات منها حاصل الحبوب (38699 ميكاغرام. ه$^{-1}$) وفي صفة وزن الف حبة اذ بلغ (30.724 غم) بينما تفوقت تجربة الديم في متوسط النمو النسبي (0.016 غم/غم /يوم) ودليل الحصاد (33.394) ونسبة البروتين (13.844 %) وكان هناك فرق معنوي بين التحربتين في الصفات .

كلمات مفتاحية : أصناف الشعير ، رش البرولين ، صفات نوعية .

Introduction

Barley (*Hordeum Vulgare* L.), is an economically important crop, and It constitutes about 12% of the world's productivity and, as it is the fourth major grain crop in the world (26). Barley has industrial and medicinal uses, including a laxative, dampening agent, and barley has a high nutritional value compared to most other crops. It is also used in the manufacture of bread after it is mixed with a specific percentage of bread flour and is used as a substitute for rice after the crust and barley have been removed and it is used in many industries, including the malt industry, and it is used as food for children after the fruiting shells are removed from Aleurone , and it is rich in dietary fiber, selenium, amino acids and vitamin B, Either at the present time, it is used as a green or grain feed, in addition to the fact that its seeds are used in the manufacture of malt, which is used in the manufacture of alcohol and medicines. As for its green plants, they are used in the work of hay, before ripening or when growing barley for the purpose of feed that is used as grains, its quality is measured mainly on the basis of the percentage of protein in the grains of the used cultivar, which is one of the oldest grain crops cultivated in the world where it was used as basic food for humans, (19). It is widely cultivated in Iraq in the centre and the south, and he confirmed (2) through his study that barley contains beta-glucan at a percentage ranging (3.23 - 4.56%). Beta-glucan is considered a soluble fiber that helps increase the viscosity of the gastrointestinal tract, as it contains the following ratios (2.13-3.14%) of carbohydrates and ash. The areas of barley cultivation are characterized by the fluctuation of rainfall from year to year, and the irregularity of its distribution during one growing season, which may lead to the exposure of crop plants to periods that may lengthen or shorten the drought (15). Drought stress is defined as a state in which the availability of the water reaches a point at which the plant cannot absorb water at the required speed to offset the requirements transpiration/

Evaporation(evapotranspiration)and weather factors, such as low relative humidity, high temperature, and intensity of solar radiation, which reduce the damage caused by drought stress (28).There are two types of stress, non-reverse stress, and here, in this case, the activity and functions of the parts of the plant do not return to the normal state when the stress is removed and the stress is an inverse biological state, which is changes that occur in plant functions that return to the normal state when the stress is removed (22). Stress reduces the level of reproductive and vegetative growth and inhibits photosynthesis and carbon assimilation, An imbalance in nitrogen metabolism and an increase in the production of a group of active oxygen (ROS Reactive oxygen species) that work to break down proteins and cellular membranes (21). The study aims to know the

effect of spraying with proline on drought tolerance of growth traits and the quantitative and qualitative traits of cultivars of barley for two stages (branching stage - elongation stage) on improving the increase of growth traits and the quantitative and qualitative traits of six cultivars of the barley crop.

Materials and methods

The experiment was conducted at the Agricultural Research and Experiments Station (Al-Sayada area) belonging to the college of Agriculture, the University of Kirkuk during the winter agricultural season (2019-2020).The experiment included the study of six cultivars of barley (Buraq, Samir, Al-Khair, Al-Hatra, Iksad and Amal) and the two stages of spraying with proline on the traits of growth and productivity and the quality of the grain of the barley crop under Rainfed agriculture and supplementary irrigation (Sprinkler Irrigation) with the aim of the effect of spraying with proline on drought tolerance to indicators of growth and productivity of barley cultivars. The experiment was conducted according to the Randomized Complete Block Design (RCBD) and by arranging the split-plot with three replicates, and the cultivation was done on 11/16/2019.As two separate experiments were conducted one under the Rainfed agriculture system and the other under the sprinkler irrigation system. The cultivated field was divided into three main plots, so that the main plots contained proline, and each subplot included each of the six studied cultivars(6 barley genotypes). Each sector contains (12) experimental units on which the treatments are distributed to reconcile the studied factors randomly, and each experimental unit includes three lines with a length of 3 m and the distance between one line is (30) cm .A number (36) g of barley grains are placed for the studied cultivars equally for each unit of testing In other words, one line placed (12) g of grains in it, meaning that the quantity of grains is equal of the cultivars and the number of grains is not equal. and that the field of the experiment was fertilized with 6 $kg.ha^{-1}$ fertilizer Dab, then added (15 kg) urea in one batch before cultivated as a preparatory batch and the second was placed a month after cultivated . The agricultural operations of irrigation and control of the broad leaves were conducted on 01/28/2020 with a pesticide 2.4-D at a volume of 750 mm which was mixed with 100 L of water, as well as controlling the thin weeds by hand and adding fertilizers as needed and according to the recommendations.

These analyzes were performed in the laboratories of the Agriculture directorate in Kirkuk

Table (1): The physical and chemical traits of field soil and irrigation water

Units	soil components	No.
21.5%	Sand g / kg	1
36.5%	Clay g / kg	2
42%	Silt g / kg	3
Sandy loam	Soil Texture	4
16.77g / kg	Lime	5
8.8 g / kg	gypsum	6
Non	carbonate	7
2.55 mg/g	EC	8
7.54	PH	9
1.238 %	Organic matter	10
25.8 mg. Kg^{-1}	Nitrogen	11

1.4 mg. Kg^{-1}	**Phosphorous**	**12**
40.9 mg. Kg^{-1}	**Potassium**	**13**
237,437 mg. Kg^{-1}	**Sulfates**	**14**
0.8 mg. Kg^{-1}	**Iron**	**15**
	Irrigation water analyzes	**16**
7.7	**PH**	**17**
2.929Dsm^{-1}	**EC**	**18**

Table (2) the cultivars obtained for conducting the research and the source for obtaining them

Source	cultivars Name	No.
Atomic Energy Organization	**Buraq**	**1**
Atomic Energy Organization	**Samir**	**2**
Atomic Energy Organization	**Al-Khair**	**3**
Atomic Energy Organization	**Al-Hatra**	**4**
IPA Center for Agricultural Research	**Iksad**	**5**
Atomic Energy Organization	**Amal**	**6**

Studied traits

1 Relative growth rate (RGR): (g / g / day) defined by Kathirvelan and Kalaiselvan (2006)

That it is a performance of the Net Assimilation Rate (NAR) function and was calculated from the following equation (Hunt, 1982):

$R.G.R. = (\text{Lin } W_2 - \text{Lin } W_1)/(T_2 - T_1)$

2 - The number of grains (grain.$Spike^{-1}$): Take a square meter of each experimental unit and calculate the number of grains in it according to the formula (grain yield * 1000 / weight of 1000 grains = product / number of spikes).

3- The 1000 grains Weigh (1 g): 1000 grains were taken from each experimental unit, which was measured in grams, after harvesting and wasting them from the spikes, and they were weighed with a sensitive scale and three ranks as indicated (Attiyah et al., 2003).

4- Grain yield (tons.ha^{-1}): a square meter of each experimental unit was calculated and the grain yield in it was calculated, and the numbers were converted to tons.ha^{-1}.

5 - Protein percentage %: The percentage of nitrogen and each of the cultivar present in the experimental units in the irrigation and Rainfed agriculture experiments was measured using the Microkjeldol device as mentioned by (AACC (1979)) by multiplying the total nitrogen percentage * constant (6.25). On the percentage of protein.

6- Drought indicators: the treatments of drought severity at each stage of the grain yield and its components.

The drought intensity factor was calculated at each stage of the grain yield and its components according to Fernandez's equation (1992).

$STI=[(YP)\times(YS)/(\acute{Y}P)^2]$

whereas

STI = Drought Tolerance Index

YP = productivity under non-stress conditions (irrigated agriculture)

YS = productivity under stress conditions (rainfed agriculture)

ÝP = average productivity of all experimental units under stress conditions

7- Statistical analysis: The data of growth traits, yield, its components, and qualitative traits were analyzed statistically by the method of analysis of variance to arrange the split-plot.

According to the Randomized Complete Block Design (RCBD), the averages were compared to the Duncan multi-range test regardless of the calculated F value, and the SAS program (2009) was used in the statistical analysis (3).

Results and discussion

1- Relative growth rate: (g / g / day)

The relative growth rate is a good criterion in the plant's stress tolerance traits and it was evident from the results presented in Table (3) for the relative growth rate trait that the rainfed agriculture-experiment that was sprayed with proline excelled significantly, where it gave the highest average for this trait, and the relative growth rate of the cultivar Buraq reached the highest average(0.025 g / g / day), while the control experiment gave the lowest average than the other, as the relative growth rate of the Iksad cultivar reached (0.009 g/ g/ day) This agrees with reported (18) who confirmed that spraying proline has a significant effect in increasing the relative growth rate and (20) and the reason may be due to the difference in genotypes and the use of spraying with proline, which in turn was sprayed on the fresh leaves, which led to a significant increase in the number of Leaves and the fresh and dry weight of the plant. The results of the same table showed that there were significant differences in the experiment of sprinkler irrigation, where the treatment that was sprayed with proline gave the highest average, as the Amal cultivar reached (0.018 g /g / day), and in the same treatment it gave the lowest rate in the Al-Hatra cultivar , which was 0.004 g / g / day.) These results are consistent with (17) who confirmed the significant effect of proline in increasing the relative growth rate, where it may be due to this may be due to the difference in genotypes and this is consistent with (12) As for the amino acid spraying proline, its effect was not clear and may return The reason is the difference in the response of the cultivars to the environmental conditions, while the treatment of the cultivars showed that the cultivar was excelled to the Amal with average (0.017 g / g / day), While the Al-Hatra and Al-Khair cultivar gave the lowest average, where it reached (0.012 g / g / day), and this is due to the genetic variation of the cultivars between them and it corresponds to (6) in the difference in the significance of the cultivars, While the average effect of proline did not show any significant difference, where the control treatment excelled on the others with a difference (0.015 and 0.013 g / g / day), respectively, and also for the average effect of the irrigation method, the Rainfed agriculture treatment was excelled on the spraying by a difference (0.016 and 0.013 g / g / day), respectively.

Table (3) The effect of irrigation and spraying methods with proline on the trait of the relative growth rate (g / g / day) of the barley crop

Average cultivars	interaction between cultivars and proline		Interaction between cultivars and irrigation method		Sprinkler Irrigation		Rainfed agriculture		Cultivars
	0.75	0	Sprinkler Irrigation	Rainfed agriculture	0.75	0	0.75	0	
a-c0.016	ab0.017	a-c0.015	a-d0.013	a0.019	c-g0.012	b-g0.014	a0.025	a-f0.016	Buraq
ab0.0168	a-c0.015	ab0.018	a-d0.014	a0.019	d-g0.011	a-f0.017	a-d0.020	a-e0.019	Samir
c0.012	dc0.009	a-c0.014	b-d0.011	b-d0.012	d-g0.010	c-g0.012	fg0.009	a-f0.016	Al-Khair
bc0.012	d0.006	ab0.018	d0.009	a-d0.015	g0.004	c-f0.015	fg0.009	a-c0.022	Al-Hatra
a-c0.013	bc0.013	bc0.012	a-d0.016	cd0.010	a-f0.015	a-f0.016	d-g0.011	e-g0.009	Iksad
a0.017	a0.020	a-c0.014	a-c0.017	ab0.017	a-f0.018	a-f0.016	ab0.022	b-g0.013	Amal

The average effect of proline	Sprinkler Irrigation	Rainfed agriculture	Irrigation method / proline
a0.015	ab0.015	a0.016	0
a0.013	b0.012	a0.016	0.75
	a0.013	a0.016	The average effect of the irrigation method

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.

- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

2- Weight of 1000 grains (g)

It was found from the results in Table (4) that there was a significant difference between the cultivars in the two treatments in the Rainfed agriculture experiment, where the Iksad cultivar in the treatment of proline excelled in the average of Weight of 1000 grains , where it reached (34.927 g). As for the Samir cultivar in the control treatment, it reached the lowest average in this experiment (22.6 These results agrees with (16) who showed that proline spraying has a significant effect in increasing the weight of 1000 grains and (7) the reason for the difference between the cultivar is due to the variation of the genetically modified cultivars, which was reflected in the difference in their response to proline and the surrounding

environmental conditions. As for the sprinkler irrigation experiment, the Iksad cultivar in the treatment of proline excelled on the rest of the cultivar in the experiment, where it reached the highest average (39,443 g). As for the Al-Hatra cultivar in the control treatment, it gave the lowest average, as it reached (25,683 g). These results agree with (4) and with (16) who showed that proline spray has a significant effect in increasing the weight of 1000 grain, and this difference may be due to the effect of proline, which worked on increasing cell division and thus increasing the plant branches bearing spikes, which led to an increase in spikes. Increase the number of grains per spike, and with regard to the average effect of the cultivars, the cultivar Iksad surpassed the rest of the cultivar, reaching (34.942) g), As for the Al-Hatra cultivar, it reached the lowest average (26.22 g), which is the lowest average among the cultivars. These results are consistent with (8). The reason for the difference between the studied cultivars may be due to their high efficiency in redistributing the products of the Photosynthesis process from the vegetative parts of the plant to the reproductive parts, especially the growing grains, which led to an increase in their weight, while in the average effect of proline the treatment of proline was excelled. The control was treated with average (31,291 and 28,211 gm), respectively, These results agree with (16) who showed that spraying proline has a significant effect in increasing the weight of 1000 grain and (27) because the cultivar may differ in the extent of their response to amino acids and proline, one of which is through spraying it on the plant, which works on the manufacture of a large group of substances Nitrogen, vitamins and enzymes, while in the average effect of the irrigation method, the sprinkler irrigation experiment showed its excelled on the Rainfed agriculture experiment with an average of (30.724 and 28.777 g), respectively.

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.

- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

Table (4) The effect of irrigation and spraying methods with proline on the weight of the 1000 grain (g) of the barley crop

Average cultivars	interaction between cultivars and proline		Interaction between cultivars and irrigation method		Sprinkler Irrigation		Rainfed agriculture		Cultivars
	0.75	0	Sprinkler Irrigation	Rainfed agriculture	0.75	0	0.75	0	
b31.4567	b34.11	d-f28.803	bc31.482	bc31.432	bc35.293	e-h27.67	b-d32.927	d-g29.937	Buraq
d26.2483	fg27.787	h24.71	d-f27.61	g24.887	e-h28.4	f-h26.82	f-h27.173	i22.6	Samir
c29.5583	c-e30.883	e-g28.233	b-d30.225	c-e28.892	c-e31.553	e-h28.897	d-f30.213	e-h27.57	Al-Khair
d26.22	f-h26.592	gh25.848	fg 25.757	e-g26.683	g-i25.83	hi25.683	f-h27.353	g-i26.013	Al-Hatra
a34.9425	a37.185	bc32.7	a38.067	b31.818	a39.443	ab36.69	bc34.927	e-h28.71	Iksad
bc30.0792	cd31.188	d-f28.97	bc31.207	c-e28.952	c-e31.667	d-f30.747	d-f30.71	f-h27.193	Amal
						The average effect of proline	Sprinkler Irrigation	Rainfed agriculture	Irrigation method / proline
						b28.2108	b29.4178	c27.0039	0
						a31.2908	a32.0311	b30.5506	0.75
							a30.724	a28.777	The average effect of the irrigation method

3- Grains yield (tons.ha^{-1})

The results in Table (5) showed that there were significant differences in the Rainfed agriculture experiment, where the Amal excelled in the control treatment with the highest average for this trait of (4100.7 tons.ha^{-1}), while the Al-Hatra cultivar in the same treatment reached the lowest average (2176.6 tons.ha^{-1}), This result agrees with (10). This is in agreement with (10). The reason for the difference may be that some varieties have a high capacity to exploit primary resources, which leads to an increase in the productive capacity of the crop. As some cultivar are excelled on others in the yield and its components, while in the spraying experiment, the Amal cultivar in proline treatment, reached the highest average, where it reached the highest average (4747.3 mcg.ha^{-1}), While the Al-Khair cultivar in the control treatment reached the lowest average (3059.9 mcg.ha^{-1}), and this is consistent with (16) and (17) who showed that proline has a significant effect on the trait of grain yield and this significant difference in the yield of grains is consistent (10), The reason may be due to the fact that some cultivars have a high capacity to exploit primary resources, which leads to an increase in the productive capacity of the crop , As some cultivars excelled on others in the yield and its components, while in the average of the cultivars , the Amal cultivar excelled and gave the average (3930.6 mcg.ha^{-1}). As for the Al-Hatra cultivar , it reached the lowest average, reaching (2885.5 mcg.ha^{-1}), The reason may be due to the variation in the genetic traits between the cultivars and to the ability of the cultivars to exploit the primary resources, which leads to an increase in the productive capacity of the crop, while the average effect of proline was excelled on the treatment of proline on the control treatment with an average of (3442.4 and 3247.4 mcg.ha^{-1}) respectively. These results are consistent with (4),While the average effect of the irrigation method, the spraying experiment excelled on the Rainfed agriculture experiment with an average of (3869 and 2803 mcg.ha^{-1}). Finally, the interaction between proline and the irrigation method, the proline treatment in the spray experiment outperformed the rest of the treatments in the two experiments, where it reached an average of (4047 mcg.ha^{-1}).As for the proline in the Rainfed agriculture experiment, it reached the lowest of the two experimental treatments, reaching (2801), and these results are consistent with (3). The reason may be explained here that the proline treatment in the Rainfed agriculture experiment decreased due to the availability of water and the temperature balance at the time of formation of the spikes.While the average effect of the irrigation method, the spraying experiment excelled on the Rainfed agriculture experiment with an average of (3869 and 2803 mcg.ha^{-1}). Finally, the interaction between proline and the irrigation method, the proline treatment in the spray experiment outperformed the rest of the treatments in the two experiments, where it reached an average of (4047 mcg.ha^{-1}).

Table (5) The effect of irrigation and spraying methods with proline on the grain yield (tons.ha^{-1}) of the barley crop

Average cultivars	interaction between cultivars and proline		Interaction between cultivars and irrigation method		Sprinkler Irrigation		Rainfed agriculture		Cultivars
	0.75	0	Sprinkler Irrigation	Rainfed agriculture	0.75	0	0.75	0	
bc3153.7	bc3425.2	bc2927.5	bc3724.7	de2468.5	a-d3981.8	b-h3467.7	f-i2590.2	hi2387.4	Buraq
ab3645.3	ab3758.2	a-c3532.5	ab4234.9	c-e3055.8	a-c4271.1	a-c4198.6	c-i3245.2	d-i2866.4	Samir
bc3286.1	ab3632.3	bc2939.9	c3424.3	cd3147.9	a-f3788.6	c-i3059.9	b-h3476.0	d-i2819.9	Al-Khair
c2885.5	bc3014.7	c2756.3	bc3478.5	e2292.4	a-g3621.1	b-i3335.9	g-i2408.3	i2176.6	Al-Hatra
bc3144.0	bc3277.1	bc3010.8	bc3711.3	de2576.7	a-e3875.4	b-h3547.1	e-h2678.8	g-i2474.6	Iksad
a3930.6	a-c3544.1	a4317.2	a4640.4	cd3220.9	a4747.3	ab4533.6	hi2341.0	a-c4100.7	Amal
						The average effect of proline	Sprinkler Irrigation	Rainfed agriculture	Irrigation method / proline
						a3247.4	a3690.5	b2804.3	0
						a3442.4	a4047.5	b2801.6	0.75
							a3869	a2803	The average effect of the irrigation method

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.
- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

4- Harvest index%

The results in Table (6) showed the traits of harvest index in the Rainfed agriculture experiment that the Al-Khair cultivar was excelled in the treatment of proline, where it reached the highest average (41,267), while the Amal cultivar in the control treatment reached the lowest average (29,000) and these results agree with (1).The reason may be due to the fact that spraying proline at certain stages helps in stimulating the division of meristematic tissues and increasing the production of growth hormone, which has an important role in cell division and elongation, as well as has a role in the manufacture of enzymes, and adding the amino acid proline after (60 days) of cultivation had an effect. The increase in the harvest index, as for the sprinkler irrigation experiment, the Samir cultivar in the treatment of proline reached the highest average, as it reached (38.067), As for the Iksad cultivar in the control treatment, it reached the lowest average (29,000), respectively. The reason for the excelled of the cultivar treated with proline may be due to the fact that proline acted as a regulator inside the plant cells and affected the process of opening and closing stomata in the leaves and the process of water absorption in them through the root cells and this led to an increase The efficiency of water consumption, which plays a role in increasing the tolerance of the crop due to the lack of moderate water, and it also has a role in stimulating the buds for growth, which led to the increase in the branches of the plant and because the cultivated varieties differ in their response to proline in their growth due to the difference in their genetic makeup. Therefore, they followed a different behavior. While the average of the cultivars, the Samir cultivar reached the highest average (35,382), while the Iksad cultivar reached the lowest average (31,382). Therefore, it differs in the yield and its components and thus differs in the average of the harvest index, while the proline effect the proline treatment excelled on the control treatment where it reached (32.847 and 33.529), while the average effect of the method of irrigation, the Rainfed agriculture experiment reached the highest average, as it surpassed the spraying experiment, reaching (33.394 and 32.978), respectively.

Table (6) The effect of irrigation and spraying methods with proline on the harvest index of the barley crop

Average cultivars	interaction between cultivars and proline		Interaction between cultivars and irrigation method		Sprinkler Irrigation		Rainfed agriculture		Cultivars
	0.75	0	Sprinkler Irrigation	Rainfed agriculture	0.75	0	0.75	0	
ab32.382	b31.52	ab33.1	b-d31.967	a-d32.88	bc31.233	bc32.7	bc31.95	bc33.500	Buraq
a35.467	ab36.35	ab34.583	ab36.117	a-c34.817	ab38.067	bc34.167	a-c34.633	a-c35.00	Samir
ab34.025	a36.617	b31.433	cd30.967	a37.083	bc31.967	c29.967	a41.267	bc32.9	Al-Khair
ab32.975	ab31.517	ab34.433	a-c34.633	b-d31.317	bc32.9	a-c36.367	c30.133	bc32.500	Al-Hatra
b31.917	ab32	ab31.833	d29.5	a-d34.333	c30	c29	bc34	a-c34.667	Iksad
ab32.267	ab32.833	ab31.700	a-c34.683	d29.85	a-c34.967	a-c34.4	c30.7	c29	Amal

The average effect of proline	Sprinkler Irrigation	Rainfed agriculture	Irrigation method / proline
a32.847	a32.767	a32.928	0
a33.529	a33.189	a33.888	0.75
	a32.978	a33.394	The average effect of the irrigation method

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.

- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

5- Protein percentage(%)

It was found from the results of Table (7) in the Rainfed agriculture experiment that the Al-Khair cultivar in the treatment of proline excelled and gave the highest average amounted to (15.400%), while the Samir cultivar in the control treatment was the lowest average (13,000%). These results are consistent with (3) who confirmed the presence of significant differences in the protein percentage of the barley plant when sprayed with amino acids, and proline was one of them and with (28), While the spraying experiment was, the Samir cultivar in the treatment of proline excelled and gave the highest average of (14.067%), while the Amal cultivar in control treatment reached the lowest average (8,500%) and it is consistent with (9) and (3) who confirmed that the protein percentage is affected by several factors, including environmental and genetic, as well as the fertilizers that were added during the cultivation process, while in the average cultivars, the Al-Khair cultivar excelled and gave with the highest average, reaching (14.150%),While the Amal cultivar has reached the lowest average (12.383%), and these results are consistent with (3). The reason may be due to the genetic difference of the cultivars in addition to their impact on environmental conditions, While in the average effect of proline, the treatment of proline excelled on the control treatment with an average of (14.091 and 12.752%), respectively. These results are consistent with (5), and the reason may be due to the difference in the genotypes of the cultivars as well as the difference in temperatures during the dry matter accumulation phase. and it agrees with (3) who confirmed that spraying proline and amino acids increase protein, while in the average effect of the irrigation method, the Rainfed agriculture experiment in the spraying experiment excelled and gave an average of (13.844 and 12.969%), respectively, and these results agree with (6) and the reason may be due. To the genetic difference between the cultivars and the extent of their vulnerability to environmental conditions, including water, as the availability of water quantities is inversely proportional to the percentage of protein.

Table (7) The effect of irrigation and spraying methods with proline on the percentage of protein% of the barley crop

Average cultivars	interaction between cultivars and proline		Interaction between cultivars and irrigation method		Sprinkler Irrigation		Rainfed agriculture		Cultivars
	0.75	0	Sprinkler Irrigation	Rainfed agriculture	0.75	0	0.75	0	
ab13.3727	a13.8400	a12.9833	a12.9800	a13.7000	a13.350	a12.733	a14.167	a13.233	Buraq
ab13.633	a14.2167	a13.0500	a13.5833	a13.6833	a14.067	a13.100	a14.467	a13.000	Samir
a14.1500	a14.600	a13.7	a13.6333	a14.667	a13.800	a13.467	a15.400	a13.933	Al-Khair
ab13.3500	a13.8	a12.9000	a13.3333	a13.3667	a13.600	a13.067	a14.000	a12.733	Al-Hatra
ab13.5833	a14.1167	a13.0500	a13.2833	a13.8833	a13.500	a13.067	a14.733	a13.033	Iksad
b12.3833	a13.9333	b10.8333	b11.0000	a13.7667	a13.500	b8.500	a14.367	a13.167	Amal
						The average effect of proline	Sprinkler Irrigation	Rainfed agriculture	Irrigation method / proline
						b12.7528	c12.3222	bc13.1833	0
						a14.0914	ab13.6529	a14.5056	0.75
							b12.9686	a13.8444	The average effect of the irrigation method

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.

- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

6- Drought tolerance average.

The results in Table (8) for the trait of drought tolerance average in the interaction between cultivars and proline showed that the Amal cultivar in the control treatment excelled on both of the two treatments as it reached (0.907), followed by the Samir cultivar in the treatment of proline as it reached (0.895) and the cultivar

hopeful in the control treatment is the most drought tolerance, average that this cultivar is basically a drought tolerant cultivar, meaning that its genetic makeup allows it to do so without adding proline, This applies to the Samir cultivar in the control treatment, as it reached (0.762), meaning that the genetic susceptibility of these two cultivars has the ability to withstand drought, meaning that this basically indicates that these cultivars are drought tolerant in their genetic makeup. While the Al-Hatra cultivar in the control treatment is one of the most sensitive to drought, as it reached (0.483), while the Al-Khair cultivar in the comparison treatment reached (0.587), meaning that it is sensitive to drought and when adding proline it became (0.871) so it became tolerant to drought, meaning that the addition of proline, as well as the type of depression in The control treatment, was found to be sensitive to drought, as the average reached (0.599), and when proline was added, it became resistant as it reached (0.723), the Buraq cultivar in the control treatment was sensitive as it reached (0.565), while in the proline treatment it became (0.689), so it became more tolerant to drought. These results agree with (18) who confirmed that proline has a significant effect on plant drought tolerance. With regard to the average effect of the cultivars , it was found that the Amal cultivar is the most tolerant of drought among the other cultivars, as it reached (0.838), followed by the Samir cultivar , as it reached (0.828). As for the Al-Khair cultivar, it was found that it is the most sensitive to drought, reaching (0.536). It should not be forgotten that the difference in the cultivar resulted in the expression of a trait controlled by genetic factors, and finally the average of the effect of proline, as the proline treatment in the control treatment excelled and gave the average (0.756 and 0.650), respectively. These results are consistent with (27) who confirmed an increase in the percentage of proline during drought periods.The following is an index to drought tolerance if the value was (1) or close to the one, meaning that it is drought tolerant and the farther from the one, the more sensitive it is to drought until it approaches zero.

Table (8) The effect of irrigation and spraying methods with proline on the drought tolerance average of barley crop

The average effect of proline		Average cultivars	interaction between cultivars and proline		Cultivars
0.75	0		0.75	0	
a0.756	b0.650	bc0.628	a-c0.689	bc0.565	Buraq
		a0.828	a0.895	ab0.762	Samir
		ab0.729	a0.871	bc0.587	Al-Khair
		c0.536	bc0.588	c0.483	Al-Hatra
		a-c0.661	a-c0.723	bc0.599	Iksad
		a0.838	ab0.769	a0.907	Amal

The values followed by the same letter for each of the cultivars, methods of irrigation, proline and interactions were non-significant.

- The values followed by different letters for each of the cultivars, methods of irrigation, proline, and interactions contain significant differences.

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