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THE ROLE OF PROLINE CONCENTRATIONS IN IMPROVING THE YIELD OF MAIZE (*ZEA MAYS* L.) PLANT UNDER WATER STRESS CONDITIONS

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Abstract

A field experiment was carried out during the autumn season (2016 -2017) in the field of one of farmers in the Nile - Mahaouil –Babylon province within line latitude north 32.31' and east longitude 44.21' ,To study the role of proline acid in improving the yield of maize (*Zea mays* L.) under conditions of water stress, according to the randomized complete block design (RCBD) Factorial experiments with three replicates, The first factor Extended irrigation frequency was repeated every 6 days, irrigated every 12 days and irrigated once every 6 days, followed by a 12-day regimen (I_1, I_2 and I_3) respectively. The second factor sprayed with concentrations proline acid of (0.50.100 and 150) $mg.L^{-1}$ symbol with code (P_0, P_1, P_2 and P_3) respectively. The results showed that plant height and surface characteristics And the chlorophyll content index in the leaf under the cannula reached with mean (192.81 cm, 4868 cm 2, 60.42 SPAD),The yield of I_1 irrigation was higher in the number of rows in Ear, the number of grains in the row, the number of grains in Ear and the grain yield in giving the highest averages (15.01 rows. ear^{-1}, 36.64 grain. row^{-1}, 541.1 grain. ear^{-1}, 6.43 tons E^{-1}) respectively, whereas the proline was superior to the concentration P2 in plant height and chlorophyll content index in the leaf under the clover with mean (172.03 cm, 50.10 SPAD) respectively, while P3 was higher than the total leaf area of the plant,While the concentration of P3 above the characteristics of the above and gave the highest averages (14.03 rows. ear $^{-1}$, 29.62 grain. row^{-1}, 393.1 grain. ear^{-1}, 5.12 tons E^{-1}) sequentially which was not significantly different with P2 concentration. Interference does not interfere with the irrigation duration and concentration of proline used.

***Keywords*:** Irrigation timing, spraying proline, growth maize.

Introduction

Water is very important to plant survival as solvent and vector liquid for most materials, it is prepared to energy of carbonic synthesis which is important mechanism for making organic food (Daryanto *et al.,* 2016).

The water loss in plant protoplast under drought conditions (Absence of moisture which important for plant growth) leads to raise ions concentration in protoplast caused toxicity, protein degradation and membranes fusion (AL-Sahoki *et al.,* 2009), addition to its negative effect in metabolism processes which included synthesis efficiency reduction and accumulation of organic acids like (malate, citrate, lactate etc.), resulting in the lack of protein production plant in general (Fereres and Soriano, 2007).

Iraq site is located into dry area, so this was making it threatened by lack water because the Receding of Seasonal rains to low levels (under 100 mm) and Climate Variations like high heat with lack in rivers water, so the farming of any summer crop is risked under lack water conditions, this conditions lead to search new methods in water use such as deficit irrigation Which means not to give the crop the full needs of water, but the deletion of the effects of the least impact on the yield (Almini, 2004).

Water stress on corn crop lead to increase free amino acid such as proline which increase its level in leaves 10 more than in leaves of wheat, rice and bean with 100 more than in sunflower and tobacco (Taie *et al.,* 2013). Another studies indicated increase proline under stress conditions, so any external addition of proline will be increasing stress tolerance (Zadehbaghri *et al.,* 2014) from decrease in osmotic stress in cells (increase the moisture effort) and increase cell ability to pull water because a proline is Considered as osmotic regulator and cell membranes stability in maize (Shahid *et al.,* 2014; Al-Shaheen *et al.,* 2014) and many physiological, morphological changes which caused from proline, the treatment in proline lead to growth improvement and increase yield, its composite in many crops (Farhad *et al.,* 2015; Abbas and Alak, 2016; Al-Meini, 2009), noted the increase period among irrigation from 7 to 14 days with 200 kg nitrogen fertilizer caused reduction in plant height, leaf area, yield and its composite in maize.

Studies showed that the number of ears/plant did not change much under the prevailing stress conditions for water stress and nutrients, but the effectiveness of the ear in containing the number of grains/ear is the most affected by the stress (Alousi, 2005). Also found that the decrease in maize grains yield by 24% Rows in ear, number of grains per row and weight of grain, which resulted from water stress due to water occlusion during different growth stages (Kebede *et al*., 2014).

Hayat *et al.* (2012) note any addition proline kept plants from water stress effects and increase its tolerant, proline do not only work as osmotic regular but it work as claw for metals, antioxidant, transduction molecular, improvement of mitochondria functions, effect in plant growth and increase activity of gene expression in some genes responsible for abiotic stress tolerance and the basic role of proline is modification of cell effort under abiotic stress (Savaure and Szabados, 2009).

Another studies indicator spray proline on plants improve the tolerance of negative effects from water stress (Ali *et al.,* 2013; Ashraf and Fooleed, 2007). Mohammad, (2014) found spray proline on plants 200 $mg.L^{-1}$ with 20 $mg.L^{-1}$ abscisic acid decreased from water stress under loss 75% available water and it gave increase in plant height, leaf area and grains yield. noted spray proline 200 mm on maize plans gave increase in plant height, leaf area, chlorophyll content and grains yield with composite (number of classes/ear, number grains/ear, grain 100 weight and plant yield), Saddon and Zakaria, (2016) indicator to increase in plant height in maize under 200 $mg.L^{-1}$ proline spry caused increase in number of leaves, leaf area Compared to did not spraying and these results are similar to those obtained (Mohammad, 2014).

Maize is one of summer crops needs high water requirements (750-900 mm), it need different irrigation methods to less water use from the crop for getting high water efficiency, so this study conducted to study effect increase period among irrigations and spray proline on some vegetative and yield traits in middle areas of Iraq.

Materials and Methods

Field experiment was carried out during the autumn season (2016) in the field of one of the farmers located in the Nile / Hilla district /Babil province, In order to study the effect of different concentrations of propylene acid and its relationship with water stress in some of the characteristics of growth and yield and components of maize crop, A sample of the soil was taken at a depth of 0-0.50 m randomly and from several areas prior to the beginning of the cultivation process to identify some physical and chemical field soil properties. After mixing, the sample was taken as representative and the results were as in Table (1).

Table 1 : Some chemical and physical properties of soil

The value	Unit	Property
161	$gm.kg^{-1}$ soil	Sand
480	$gm.kg^{-1}$ soil	Salt
359	$gm.kg^{-1}$ soil	Clay
Saltly clay mix		Tissue
36	$mg.Kg^{-1}$ soil	N Actve
28	$mg.Kg^{-1}$ soil	P Actve
156	$mg.Kg^{-1}$ soil	K Actve
3.30	$dc.m^{-1}$	Electrical conductivity (soil paste extract)
7.8		PH

*Soil analysis was conducted in the central laboratory of the Department of Soil and Water Resources / Faculty of Agriculture / AL-Qassem Green University

The soil of the experiment was plowed by two orthogonal plows using the plowshare plow and was fitted with disk compartments and was sorted and divided into experimental units according to the design of the randomized complete block design RCBD In the order of the global experiments and three replicates, planted the seeds of yellow maize (dawn-1) on 23 July 2016 (first irrigation) on lines and the area of experimental unit 3 m × 4m, Which included 5 lines length of three meters and the distance between the line and another 0.75 m, between Joura and another 0.25 m to obtain the density of plant 44000 plant hectares.1.5 m intervals were left between experimental units and 3 m intervals were left between the replicates to prevent leakage of water between the plates. The plants were reduced to one plant after 14 days of germination.

Add urea fertilizer at a rate of 400 kg. Ha^{-1} and in two batches: the first consisted of 200 kg. Ha^{-1} with 260 kg. $Ha^{-1}$of the triple superphosphate in agriculture. The second batch was added after five weeks of planting Seamier Critic L., a yellow corn stalker, was tested using 10% effective diazinon and 6 kg. Ha^{-1} received at the heart of the plant after 20 days of planting and three times and with a time interval of 10 days. The bush was removed by hand. The experiment included three irrigation regimens (6 days), irrigating every 12 days and irrigation, alternating once every 6 days, followed by irrigation every 12 days. (I1, I2, and I3) respectively, while the second factor represented four proline spraying factors: 0, 50, 100 and 150 mg. Its code (P0, P1, P2 and P3) is sequentially.

The concentration of the proline acid was prepared from a primary solution of 1000 mg / l. -1 by dissolving 1 g of propylene acid at 1000 mg / l. In accordance with the mitigation law, the concentrations used were as follows:-

Add the turbo-propylene acid to the vegetative group in the eight-leaf phase and re-spray to the same concentrations in the stage of 12 sheets, put the solution in a 16-liter backlit spray, taking into account the times of early morning or evening spraying to avoid high temperatures and the impact of high winds, A spray material (Zahi) was added to the spray solution in a quantity of 15 cm 3 per 100 liters to reduce the surface tension of the water and to ensure the complete wetness of the leaves

Attributes Studied

Plant height (cm): Taken as an average of ten plants from each experimental unit and measured from the surface level of the soil to the lower node of the male bulb

The total leaf area of the plant (cm^2): Calculated after the completion of the female reproduction of the following equation taken from EL-Sahookie (1985) by multiplying the length of the leaf (cm) in the maximum width (cm) of the leaf under the main clove × 0.75

Directory of Chlorophyll content in the leaf under the SPAD: was measured using a Japanese portable device manufactured by the company (Minolta) as an average of three readings per leaf and ten sample plants in the stage of female flowering

Number of rows (row. ear^{-1}): As of five Aranis of the intermediate lines and extracted the average.

The number of grains per row (P^1): calculated as the mean of five Aranis of the middle lines.

The number of grains in Ear (Ear 1): was calculated from the number of grains multiplied by the row and the number of rows in Ear as an average of five Aranos from the intermediate lines.

Weight of grain (gm): 500 tablets were taken randomly from the seeds of Aranis plants of the lines guarded from each experimental unit secondary and dried the electric oven at a temperature of 65 m 0 and until the stability of weight.

Total grain yield (kg.ha^{-1}): The weight of grain was extracted after subtraction of five arabes, which was taken randomly from each experimental unit and about to hectare $^{-1}$ on the basis of the density used in the study

Biological yield (kg.ha^{-1}): harvested five plants taken randomly (all parts of the plant except roots), then dried the initial drying under the sun and then dried in an oven at 65 °C for 72 hours, and dried at 105 °C for three hours Weight after weight stability (AOAC, 1975) and weights were then weighed to the number of plants per hectare.

Harvesting index (%): By dividing the grain yield on the biological score multiplied by 100. (Statistical data were statistically analyzed using the GenStat program and the mean was measured by LSD at a probability level of (0.05).

Results

The table of arithmetic averages table (3) shows significant differences in irrigation intervals in most studied traits, as She excelled The irrigation treatment (I_1) in the plant height, total leaf area of the plant and the chlorophyll content index in the leaf under the ear were superior. The average yield was 192.81 cm, 4868 cm^2 and 60 SPAD, Sequentially Compared to the irrigation treatment (I_2) given lowest mean of the above characteristics was 149.81 cm, 3974 cm 2 and 36.63 SPAD respectively. This result is consistent with the results of the mechanisms of Ali *et al*. (2007), which indicated that low photosynthesis Due to the effect of drought on the chloroplast the leaf thus reduced the chlorophyll content of the leaf and change p The gaps are reduced by reducing the leaf area (Dawood, 2016; Anjum *et al*., 2011; Hayat *et al*., 2012).

The same table (3) indicates the significant effect of proline concentrations in both plant height, chlorophyll content index and leaf area. The concentration of proline P_2 did not differ significantly from P_3 concentration and gave the highest height of the plant and the largest guide of chlorophyll content of the leaf under the ears with averages of (172.03 cm and 50.10 cm^2), while the non-spray treatment P_0 (comparison) Less means (164.60 cm and 46.11 cm^2), while the leaf area gave P_3 the highest mean (4477 SPAD) and did not differ significantly with the P_2 concentration while the non-spray treatment P_0 (comparison), With a mean average of 4255 SPAD. This corresponds to the results of the mechanisms of (Ashraf and Foolad, 2007) In addition, some studies have suggested that propylene spray leads to a hormonal balance by controlling the opening and closing of the stomata and thus maintaining the chlorophyll ratio of the decrease and thus increasing the leaf area (Sadon and Zuraini, 2016).

The results of Table (4) showed a significant effect of irrigation periods on both yield traits and components, while these dates did not have a significant effect on grain weight. The irrigation duration (I_1)

recorded the highest mean number of rows in ear, number of grains per row, 15.01, ear^{-1}, 36.64 grains, 541.1 grains. ear^{-1}, 6.43 tons^{-1}) respectively, which differed significantly with the duration of irrigation (I_2) and (I_3).

Table (4) shows that there is a significant effect of the proline concentrations in the traits of the crop and its components. P3 gave the highest average number of rows of ear, the number of grains in the row, the number of grains in the ear, and the grain yield reached (14.03 rows. ear^{-1}, 29.62 grains. row, 393.1 grain.ear^{-1} 1, 5.12 tons.hI^{-1}) respectively, which differed significantly from the rest of the concentrations while the non-spraying P_0 (comparison) gave the lowest arithmetic mean (14.03 rows. ear^{-1}, 29.62 grains. row, 393.1 grain.ear^{-1} 1, 5.12 tons.hI^{-1}).

The results of Table (4) indicate that the spacing of the irrigation periods caused a significant reduction in the biological yield and the harvest index. The irrigation period (I_1) recorded the highest biological yield and harvest index with an average of 17.82 tons.hI^{-1} and 38.3% Which differed significantly with the treatment (I_3). While the irrigation treatment (I_2) gave the lowest average of 13.44 tons.hI^{-1}and 27.7% The decrease in the biological yield is due to the decrease of the components of the dry matter represented by the height of the plant. Table 3 The leaf area Table (3) The number of rows in ear and the number of grains in the row reflected the total yield.

The results of Table (4) showed that there was a significant effect of the proline concentrations in the biological yield and the harvest index. Concentration (P_3) gave the highest mean of the biological yield (16.91 tons.hI^{-1}). It did not differ significantly from the (P_2) While the treatment of non-sprayingP0 (comparison)The lowest average biological yield reached (14.87 tons.hI^{-1}), The harvest index gave the spray with the proline when treatment (P_2) Highest value reached (34.2)% did not differ significantly from the concentrationP_3while the non-spray P0 (comparison) gave the lowest value (32.6%).

Table 3: Effect of irrigation period and proline precipitation in some growth and yield of maize

Number of grain per ear	**Number of row per ear**	**guide of Chlorophyll content in the leaf under the ear (SPAD)**	**Total leaf area of plant (cm^2)**	**Plant Height (cm)**	**Concentration of proline acid**	**irrigation period**
35.53	13.73	58.03	4832	188.97	P_0	I_1
36.10	14.63	59.09	4885	191.07	P_1	
36.40	15.10	62.57	4733	196.17	P_2	
38.53	16.57	61.99	5020	195.03	P_3	
19.83	9.93	34.50	3821	146.33	P_0	I_2
20.73	10.30	35.13	3911	147.87	P_1	
21.70	10.50	38.20	4138	156.00	P_2	
22.53	11.60	38.70	4025	149.03	P_3	
26.27	11.93	45.81	4111	158.50	P_0	I_3
27.03	12.97	46.92	4175	160.23	P_1	
28.47	13.20	49.53	4338	163.93	P_2	
27.80	13.93	48.27	4387	165.73	P_3	
Ns	**Ns**	**Ns**	**Ns**	**Ns**	**LSD 0.05**	
36.64	15.01	60.42	4868	192.81	I_1	
21.20	10.58	36.63	3974	149.81	I_2	
27.39	13.01	47.63	4253	162.10	I_3	
1.12	**0.96**	**2.820**	**104.4**	**4.506**	**LSD 0.05**	
27.21	11.87	46.11	4255	164.6`0	P_0	
27.96	12.63	47.05	4324	166.39	P_1	
28.86	12.93	50.10	4403	172.03	P_2	
29.62	14.03	49.65	4477	169.93	P_3	
1.31	**1.10**	**3.25**	**120.6**	**5.04**	**LSD 0.05**	

Table 4: Effect of irrigation period and proline acid in Characteristics and yield of maize

Harvest Index (%)	Biological yield (ton.ha^{-1})	Grain Yield (ton.ha^{-1})	Weight 500 grain(g)	Number of grain per ear	Concentration of proline acid	Irrigation period
37.1	16.89	6.21	110.40	510.0	P_0	I_1
38.1	16.93	6.31	112.07	528.3	P_1	
37.6	18.26	6.63	110.77	563.3	P_2	
42,0	19.20	6.57	109.33	563.0	P_3	
24.8	13.10	3.25	102.60	196.6	P_0	I_2
25.1	13.20	3.31	101.63	214.0	P_1	
31.5	14.09	3.41	100.13	236.0	P_2	
31.3	13.36	3.64	106.33	238.7	P_3	
33.0	14.63	4.78	103.37	331.9	P_0	I_3
33.6	14.77	4.85	105.13	350.5	P_1	
31.5	17.67	4.77	109.80	373.0	P_2	
34.7	18.17	5.15	105.40	377.7	P_3	
Ns	**Ns**	**Ns**	**1.075**	**Ns**	**LSD 0.05**	
38.3	17.82	6.43	110.64	541.1	I_1	
27.7	13.44	3.40	102.67	221.3	I_2	
34.6	16.31	4.89	105.92	358.3	I_3	
3.40	**1.41**	**0.193**	**Ns**	**37.79**	**LSD 0.05**	
32.6	14.87	4.75	105.46	346.2	P_0	
33.2	14.97	4.82	106.28	364.3	P_1	
34.2	16.67	4.94	106.90	390.8	P_2	
34.1	16.91	5.12	107.02	393.1	P_3	
Ns	**1.63**	**0.223**	**Ns**	**43.64**	**LSD 0.05**	

Discussions

The highest yield was achieved in the treatment of I_1. This was because of short-term irrigation increased the water availability of the plant and did not suffer from stress, which reduces the growth rate, and increasing the frequency of irrigation with spaced time I_2 resulted to a significant decrease in grain yield 47% compared to the I1 treatment.

The results of Table (4) showed This is due to the decrease in its components. The number of rows decreased by the number of grains, the number of grains per row, and the decrease in the number of grains of ears is due to the reduction of the number of ears in the ear that resulted. (Alusi, 2005). Because the number of grains is related to the number of grain sites that arise early and the exposure to stress at this stage causes a decrease in the length of the ears and the number of grain sites, (Carpici, 2009 and Okay, 2006).

Studies suggest that exposure of maize plant to water stress during of the drought-induced shortage of fertile flowers and the number of grains in plants exposed to water stress before flowering and single-grain weight when exposed to post-flower stress can be attributed to Hormonal effects (Kaya, 2006), in addition to the tension at the time of flowering lead to the drying of pollen and then increase in the interval of female flowers anthesis and loss of leaves in early time and then the number of grains (Araus *et al*., 2012).

As well as the water stress, which may lead to the failure of the pollination and fertilization, which is related to the availability of moisture at this stage, pollen grains to moisture to stick to the anthers in addition to the evolution of the tube after the pollination of pollen when the lack of moisture Turgut and others 2005).

The oxidative processes which presumably increased during aging stress, increase in aging period caused an increased in solute leakage and a decrease in germination percentage in maize, sun flower, and cucumber seeds subjected to accelerated aging conditions (Sahib and Hussein, 2014; Hussein *et al*., 2012a; Hussein *et al*., 2011). Accelerated ageing of seeds up to three days had significant effect on Amadori products and glutathione reductase and peroxidase activity in maize and sunflower seeds (Hussein *et al*., 2012b; Hussein *et al*., 2012c). Al-Delaimyand Al-Mamoori (2018) mention that there is a significant increase in rooting response of aged mung bean cuttings by using different concentration of H_3PO_4 The decrease in the height of the ears and its diameter, which is distributed over the grain sites, indicates that the water stress lead to decrease the leaf of leaf area lack of (Table 3), plant height (Table 3) and chlorophyll content index (Table 3). This is reflected in the efficiency of the photosynthesis process and the lack of dry matter formed in the ears and therefore Reducing the size of the droplets, which causes the reduction of the microprocessor, which causes the reduction of Co_2 transport carriers and low concentration in the leaf, thus reducing the rate of transpiration (Anjum and others, 2011)

That achieve a big ears(the increase in the number of grains and the number of row) depends on the supply of photosynthetic products This mechanism has to be through the surface of the surfaces (Green tent) and its effectiveness in intercepting light and converting solar energy into dry matter in the period between the evolution and development of the ears (V8 - V14). This is what Muhammad (2013) said. The small size of the leaf area and the low growth rates caused by water stress, Cereals in the row, number of rows and then number total grains.

The increase in the result of sprinkling of the prolin is due to the increase of its components represented by the number of grains in ears, which consists of the number of grains in the row and the number of rows in ears and increasing them increase the diameter of the ears and thus the number of rows and the number of pills more and this reflects the total grain yield as the spraying prolin preserves the materials produced and easy to transfer To increase the number of fertile grains and increase their number. These results were consistent with Asadi (2015), noting that spraying of prolin with relatively increased concentrations increased the total number of grains of ears by increasing the proportion of nutrients and their fertilization as well as the source of nitrogen helps the formation of protein and make use of them in the formation of the origins of flowers during the fertile phase of the contract (Abbas and Alec, 2016 and Dmello, 2015) found that spraying of the leaf proline increases the number of grains per plant.

Prolin spray on the leaves increased concentration of chlorophyll and preserves cells Proline increases its concentration in the leaf, improves its water content and prolongs the period in which the leaf remains effective and delays. Aging of leaf (Sun and Hong, 2010). Proline spray on leaf increases the concentration of chlorophyll and preserves cells from apoptosis through the promotion of free radicals. Kishor *et al*. (2014) and Kaya *et al*. 2006). Proline spraying reduces the process of protein degradation, which leads to the production of harmful acids such as clotamics, aspartic acid, and converting them into proline is a defensive method to reduce the effect of these acids (Stewart, 1983).

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