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ORIGINAL ARTICLE

EFFECT OF FOLIAR SPRAY WITH ASCORBIC ACID ON TWO MAIZE CULTIVARS GROWN UNDER SALINE SOIL

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Abstract: Field experiment was conducted to investigate the impact of different concentrations of ascorbic acid (0,2, 4, 6, 8 g/ l) on some growth characteristics, grain yield and of two maize cultivars (Furat, Buhooth-106) at the farm of field crops department, Agriculture College, University of Basrah, Iraq, during Autumn season 2019. The experimental design was split-split plots using Randomized complete block design (RCBD) with three replicates. Where ascorbic acid treatments placed in the main plots, while the sub plots includes the cultivars. Furat genotype gave the highest yield of 144.25 g/m^2. Spraying ascorbic acid at the concentration of 8 g /l produced maximum yield of 173.89 g/m^2. Minimum grain yield was found in control treatment (106.60 g/m^2). Furat genotype spraying with high concentration of ascorbic acid 8 g/l was superior with 191.97 g/m^2 compared to all interactions.

Key words: Maize, Ascorbic acid, Cultivars, Grain yield.

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1. Introduction

Maize (*Zea mays* L.) is one of the important cereal family crops. It ranks third after wheat and rice in cultivated area and first in production in the world. It is grown mainly as direct human food, livestock and poultry feed and their entry as a raw material for industrial purposes like starch, oil [Imran (2015)]. On the other hand, it is a source of proteins carbohydrates, vitamins, and minerals [Gopalan *et al.* (2007)]. Its importance is also attributed to its high production capacity and its adaptation to different environmental conditions, but really the average yield of maize is still less than that of developing agricultural countries such as united states (11.20 tons/hectare) Turkey (11.40 tons/hectare) and Canada (10.40 tons/hectare), according to the statistics of United States Department of Agriculture [USDA (2020)]. This low maize yield in Iraq is due to many of problems facing crop cultivation in Iraq, the most important is soil salinity, which plays a major role in evaluating productivity and requires the study of all scientific methods which increase its production, Therefore, it became necessary to use new methods that increase the productivity of the crop, such as the use of chemicals that are safe in the environment and do not have a negative impact on humans and animals. The small antioxidant molecule Ascorbic acid (vitamin C) is an organic compound that plants need in small quantities to maintain their normal growth [Amin *et al.* (2008)] and plays multiple roles in plant development, for example in cells division, cell wall extension, and other phases of growth [Strain and Fletcher (2003), Pignocchi and Foyer (2003)], as well as it protects plants against oxidative damage [Smirnoff and Wheeler (2000)]. Many researchers mentioned that ascorbic acid plays an important role as cell division and differentiation regulator and has a wide range of important functions including antioxidant protection, photo protection, photosynthesis, growth regulation, resistance of plants to environmental stresses, such as drought and salinity [Farouk (2011), Darvishan *et al.*

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(2013) and Yaghoubian *et al*. (2014)]. The aim of this research is to find out the effect of foliar application of salicylic acid saline soil conditions in some vegetative and productive characteristics of two varieties of maize

2. Materials and methods

The experiment was conducted in the fields station of Agriculture College, University of Basrah Agriculture, Iraq (30° 57' N lat., 47° 80' long.) during Autumn season 2019 to investigate the response of two maize varieties (Furat,Buhooth-106) to foliar spray with five concentrations of ascorbic acid (0, 2, 4, 6, 8 g/l). The operations of plowing, smoothing and leveling were conducted. The experiment was laid out in a Randomized complete block design (RCBD) which was arranged in split plot design with three replications. Ascorbic acid concentrations were placed as the main plots while varieties as subplots. Some physical and chemical characteristics of experiment soil were analyzed as shown in Table 1 according to the methods described by Page *et al*. (1982), planting date was in 15th of August 2019. Area of subplot was 12 m^2 (3*4 m) including four ridges about 4m length with 70 cm distance between them, 25 cm between plants and the density of plants was 8/m^2. According to recommended practices for maize recommended dose of N, 120 kg/ha. [Mohsin (2007)] was applied in three equal splits, at sowing, six leafy and at tasseling stage. A uniform dose of Phosphorous fertilizer 60kg Pha^{-1} as super phosphate of 60 kg P/ha was added during seedbed preparation. Different concentration of Ascorbic acid were applied and sprayed at V10 (10 leaves collar visible) and the rest were sprayed at silking stage using a backpack sprayer. At maturity, Data were collected from the two central rows. Data was calculated on different parameters including: Growth parameters values from standard measurements were then used to determine the physiological parameters calculated by using the following formulae given by Gardner *et al.* (1985).

Leaf area index (LAI): It was calculated as the ratio of leaf area to ground area**.**

$$\text{LAI} = \frac{Leaf\ area(\left(m^2\right)}{Land\ area\ occupied\ by\ the\ plant\left(m^2\right)}$$

Net Assimilation Rate (NAR)

$$\text{NAR} = [\ (W_2 - W_1)/(T_2 - T_1)] \times [(\text{Log } LA_2 - \text{Log } LA_1)/(LA_2 - LA_1)]\ (\text{gm m}^{-2}\ \text{day}^{-1})$$

Leaf area duration (LAD)

$$\text{L.A.D.} = (LAI_1 + LAI_2) \times (T_2 - T_1)/2(\text{day})$$

Crop growth rate (CGR): It was calculated according to the following equation by Hunt *et al.* (1982).

$$\text{C.G.R.} = (1\ /\ A) \times (W_2 - W_1)\ /\ (T_2 - T_1)\ (\text{g m}^{-2}\ \text{day}^{-1})$$

where, W_1 and W_2 = Plant dry weight at time T_1 and T_2, respectively.

A = Spacing occupied by the crop

Grain yield (GY)

Protein content: It was determined by calculating the total Nitrogen in the grain using the Kjeldahl method as described by AACC (2000), then using the formula

Protein % = % N × 6.25.

Oil content %: The percentage of oil in the grains was estimated using a Soxhlet [Al-Baldawi *et al.* (2014)].

Starch content%: The percentage of carbohydrates in the grains was estimated using a Spectro photometer at the wave length of 490 nm [AOAC (2000)].

Statistical analysis

Data were statistically analyzed using GenStat Program for split plot randomized complete block design and means between treatments were compared by least significant difference test at 0.05 level of probability, $\left(P \le 0.05\right)$.

3. Results

Leaf area index (LAI)

Data presented in Table 2 show that there was a non-significant difference between the maize cultivars by LAI. The Ascorbic acid means indicate that the LAI of plants significantly increased with the spraying of Ascorbic acid, maximum LAI was observed when Ascorbic acid was at the concentration of 8g/l which gave the best values of plant LAI (3.78), it was at a par with 6 g/l, whereas minimum LAI was recorded in control treatment (3.23). It was observed that the interaction among two factors (cultivars, Ascorbic acid spraying) showed significant variance on plant LAI, treatment (Buhooth -106 ×ascorbic acid spraying with 8 and 6g/l gave the largest LAI of plant 3.81 at a par with Furat cultivar × 8 g/l while, treatment of (Buhooth

Table 1: Some chemical and physical properties of soil study.

Properties	pH	E.C. (dc/m)	Organic matter	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)
Value	7.50	7.83	2.30	30.50	15.90	110.43

-106 cultivar × without ascorbic acid spraying gave the lowest values of plant LAI(3.11).

Leaf area duration (LAD)

There are no significant differences between the cultivars in the leaf area duration LAD as it is shown in Table 2. Furthermore, there were significant differences in the spraying with the Ascorbic acid for the LAD, the plant. Spraying at a concentration of 8 g/l recorded the highest rate of LAD (114.76 days) at a par with 6g/l, while non-sprayed treatment recorded the lowest rate reached 94.86 days. There was a significant effect of the interaction between the cultivars and spraying with the Ascorbic acid concentrations, the Buhooth -106 cultivar with the concentration of 8 g/l gave the highest rate (115.42 days), while the Furat cultivar with control treatment gave the lowest rate (94.03 days).

Crop growth rate (CGR)

The data collected in this analysis makes it very obvious. Cultivars have shown a major difference in their results for plants crop growth rate (CGR). Data shown in (Table 1) represented means of CGR trait. From the obtained results, Furat cultivar had a significantly greater CGR (1.322 g m^{-2} day^{-1}) than Buhooth-106 (1.197 g m^{-2} day^{-1}). Ascorbic acid treatment significantly enhanced the CGR. Maximum CGR was observed when Ascorbic acid was at the concentration of 8 g/l (1.369 g m^{-2} day^{-1}) compared with treatment (where the plant was grown without the spraying of Ascorbic acid) that gave the lowest values (1.075g m^{-2} day^{-1}). Table also showed that the interaction of Furat × 8 g/l Ascorbic acid led to a significant increase the CGR which gave the highest value reached 1.434 g m^{-2} day^{-1} compared with all other interactions, whereas Buhooth-106 cultivar with non-sprayed treatment recorded the lowest CGR plants (0.952 g m^{-2} day^{-1}).

Net assimilation rate (NAR)

Table 2 appeared that Analysis of variance showed significant difference for NAR between the two cultivars. Furat cultivar was superior with the average value of 0.393 gm m^{-2} day $^{-1}$, while the lowest NAR was observed in cultivar Buhooth -106 (0.356 gm m^{-2} day^{-1}). Foliar spray of Ascorbic acid had significant effect on NAR. However, the highest plant NAR (0.402 gm m^{-2} day^{-1}) was recorded with foliar spray of 8g/l of Ascorbic acid. The lowest plant NAR (0.323 gm m^{-2} day^{-1}) was measured with the control treatment. The data in Table 2 indicated that plant NAR was significantly affected by the interaction between cultivars and Ascorbic acid concentration. The maximum NAR could be obtained by sowing Furat cultivar under 8g/l of Ascorbic acid which gave 0.425 gm m^{-2} day^{-1} at a par with the same cultivar × 4 and 6g/l . On the contrary, lowest NAR was found in Buhooth-106 cultivar at the control treatment (0.303 gm m^{-2} day^{-1}).

Grain yield (g m^{-2})

The individual effects of cultivars and Ascorbic acid application and their interaction effects on grain yield of maize were significant (Table 1). Furat produced higher grain yield (144.25 g m^{-2}) while Buhooth-106 produced lower grain yield (132.91 g m^{-2}). In case of foliar application of Ascorbic acid maximum grain yield (173.89 g m^{-2}) was recorded at 8g/l while minimum grain yield was recorded at control (106. 60 g m^{-2}). The results of the same table indicated the superiority of the treatment of interaction cultivar Furat × 8g/l of Ascorbic acid, which recorded the highest rate of grain yield (191.97 g m^{-2}) compared with the treatment Forat × control which recorded 105.54 g m^{-2}.

Protein, oil, and starch contents

The data for Protein content showed that there is a significant effect to the cultivars on the protein content, where Buhooth-106 got the highest rate (12.77%) while the cultivar Furat got the lowest rate of 12.20% (Fig. 1). On the contrary, the results (Figs. 2 & 3) indicate that the Furat cultivar recorded the maximum oil content (2.76%) and starch (69.75%) as compared to Buhooth-106. Also the results showed a significant differences in the spraying of plants with the Ascorbic acid on protein, oil and starch the sprayed treatment at a concentration of 8g /l gave the highest rate of protein and oil content of 12.88% and 2.80% respectively ,while the nonsprayed treatment gave the lowest rate of

Table 2: Leaf area index (LAI) Leaf area duration (LAD, day), Crop growth rate(CGR, g m^{-2} day^{1}), Net Assimilation Rate (NAR, gm m^{-2} day^{-1}), Grain yield(GY,gm^{-2}).

Treatments		LAI	LAD	CGR	NAR	GY
Varieties	Buhooth-106	3.42	104.08	1.197	0.356	132.91
	Furat	3.47	106.45	1.322	0.393	144.25
LSD		ns	ns	0.053	0.033	3.99
Ascorbic acid g/1	0	3.23	94.86	1.075	0.323	106.60
	2	3.27	100.21	1.251	0.366	118.60
	4	3.61	106.5	1.294	0.385	140.27
	6	3.62	110.85	1.3085	0.397	153.37
	8	3.78	114.76	1.369	0.402	173.89
LSD		0.18	4.60	0.062	0.040	9.00
Buhooth-106	0	3.11	95.69	0.952	0.303	107.99
	2	3.14	96.39	1.234	0.355	120.40
	4	3.23	103.31	1.244	0.366	137.08
	6	3.81	109.60	1.252	0.377	143.26
	8	3.81	115.42	1.304	0.379	155.80
	0	3.35	94.03	1.198	0.342	105.54
Forat	2	3.41	104.02	1.268	0.376	116.79
	4	3.41	108.78	1.344	0.404	143.45
	6	3.44	112.09	1.365	0.416	163.49
	8	3.75	114.09	1.434	0.425	191.97
LSD		0.248	9.331	0.075	0.047	12.73

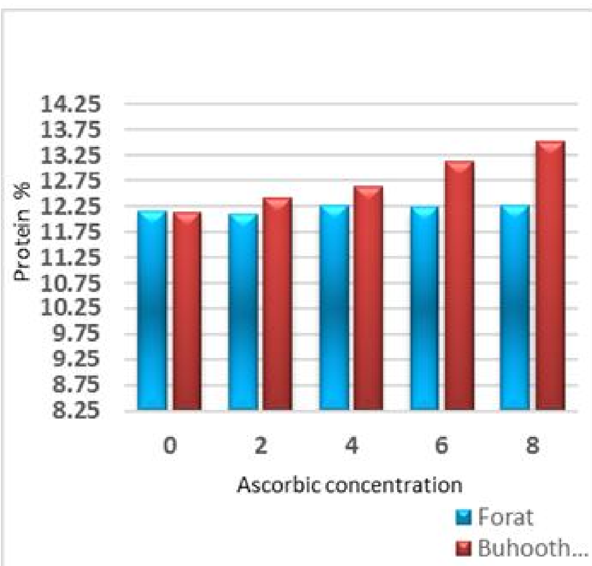

Fig. 1: Protein % influenced Ascorbic concentration of the two maize cultivars.

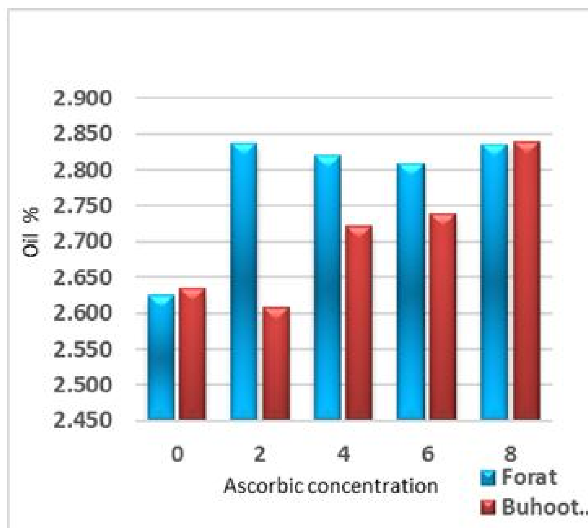

Fig. 2: Oil % influenced Ascorbic concentration of the two Maize cultivars

12.11% and 2.60% respectively (Figs. 1 & 2). As for the starch content, the results showed that maximum starch content was produced in nonsprayed treatment ((69.75%) while minimum starch content (67.55) were observed at 8g/l (Fig. 3). As well as the effect of interaction between the cultivars and the spraying on protein, oil, and starch contents, where the results indicated that there were significant differences, the Buhooth-106 and spraying at a concentration of 8g/l recorded the highest rate of protein to 13.55% (Fig. 1). The interaction of Furat cultivar with all concentrations of Ascorbic acid (except for the nonsprayed treatment) and the cultivar Buhooth-106 at 8g/l of Ascorbic acid produced the highest content of oil content (2.80%). As for the interaction between cultivars Ascorbic acid concentration as shown in Fig. 3, the treatment (Furat

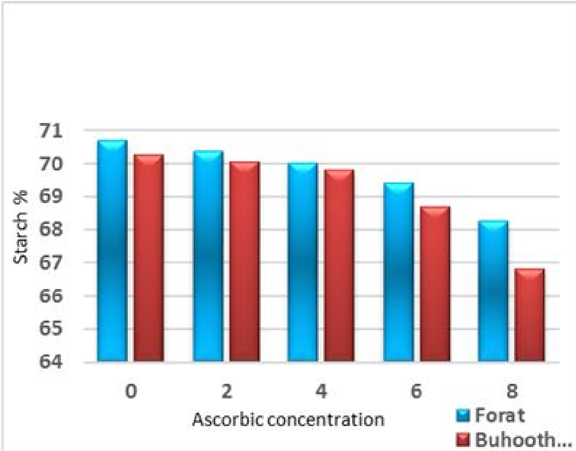

Fig. 3: Starch% influenced Ascorbic concentration of the two Maize cultivars

cultivar × nonsprayed) has excelled by On the other hand the treatment of Furat cultivar × nonsprayed of Ascorbic acid recorded the highest rate of starch amounted to 70.70% which did not significantly differ from the most interaction treatments, while the treatment (Buhooth-106 cultivar × 8g/l) recorded the lowest rate amounted to 66.83% (Fig. 3).

4. Discussion

Our previous studies have shown that these cultivars differ significantly in their physiological traits. Results presented here, that Buhooth-106 induced higher CGR and NAR compared with Furat cultivar. The genetic variations between the varieties were responsible for these results. Spraying ascorbic acid (ASA) with 8 g/l contributed to a substantial increase in growth parameters for maize plants, such as LAI, LAD,CGR and NAR, the effect is more than Ascorbic acid (8 g / l) as it increases the absorption of water and essential nutrients by changing the osmotic ability of cells,, and reducing the dangerous accumulation of reactive oxygen species (ROS) through an increase in antioxidants and enzymes [Abo-Marzoka *et al.* (2016)]. Also Darvishan *et al.* (2013) found that the use of ascorbic acid was successful in reducing the negative impact of abiotic stress on plant growth which increased leaf area and enhanced chlorophyll content of a, b and total chlorophyll, Furthermore, ascorbic acid defends metabolic processes against H_2O_2 and other harmful oxygen derivatives that have impaired many enzyme activities, reducing the damage caused by oxidative processes [Shao *et al.* (2008)]. In this regard, many researchers obtained that Ascorbic acid application has been confirmed to promote the growth of some other different plants [Adebo and Olaoye (2010)] on maize [Hussein and Khursheed (2014), Hafez and Gharib (2016)] on wheat, and [Nassar *et al.* (2016)] on flax. On the other hand, the spraying of ascorbic acid had a role in increasing the grain yield of the plant, and its action in providing the reasons leading to the increase in leaf area index, leaf area duration, crop growth rate and net assimilation ratio, photosynthesis all this was reflected in raising the efficiency of the photosynthesis process, which led to an increase in the yield.

5. Conclusion

It may be concluded from the above discussion, that crop growth rate, net assimilation ratio, grain yield and protein was significantly increased by Buhooth-106 cultivar, also treatment of 8g/l Ascorbic acid and combination Buhooth-106 and 8g/l Ascorbic acid were recorded to be the best for most of the studied traits.

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