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EFFECT OF ARGININE ON GROWTH AND YIELD OF TOMATO PLANT *(LYCOPERSICON ESCULENTUM)* UNDER DROUGHT STRESS

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Abstract

A factorial experiment with Randomized Complete Block Design was carried out in the plastic house of Diyala Agriculture Department (Baquba Agricultural Nursery) for the winter season 2018 to study the effect of drought stress and spraying with arginine in chlorophyll, carbohydrates, proline and plant yield. The experiment was conducted with three replicates using two levels of stress S_1, S_2 and three levels of arginine (0,1000,2000) mg l^{-1}. The results showed a significant increase in the level of stress S_1 in the average concentration of total chlorophyll, reaching 2.91 mg g 1 and the plant yield 1114.8 g, while the concentration of carbohydrate was significantly reduced to 18.02 mg g 1 and propylene 1.34 mg 1 compared with S2 2073 mg 1, 788.5 g, 1, 20.70 mg and 1.43 mg respectively.

The effect of arginine significantly increased the mean of total chlorophyll concentration, carbohydrate, proline and plant yield, with the highest values of spray treatment with a concentration of 2000 mg per 1 liter, reaching 3.62 mg 1, 21.93 mg 1, 1.79 mg 1, 1081 g respectively, With a concentration of O 1 mg per liter, at 2.10 mg 1, 17.03 mg 1, 0.96 mg and 820.5 grespectively

Key words **:** drought stress, arginine, tomato.

Introduction

Tomato (*Lycopersicon esculentum*) is an important economic crop all over the world . It is one of the most famous plants of the Solanaceae family. This family comprises about 85 genera and 1000 species. Tomato fruits contain a large amount of water up to 94% of its fresh weight in addition to carbohydrates, proteins, fats, salts, vitamins A, C and organic acids **(**Hassan *et al.*, 2013; Al-Dhamish, 2006**)**.

Drought stress is one of the most harm full abiotic environmental stresses (Borghett, 2009). Drought stress causes decrease in photosynthesis, chlorophyll, carbohydrate, protein content, oxidative stress, hormones and enzymatic changes (Mahmoud and Abd Al-Hussein, 2011).

Plant growth regulators are being widely used to counteract the deleterious effects of adverse environmental stresses on plants (Al-Taey and Majid, 2018). Spraying plants with amino acids, nutritious and phytohormones were effective in improving the plant's ability to withstand stress conditions, including biotic stress and abiotic stress (Velikova *et al.*, 2000). phytohormones are considered the most important endogenous substances for modulating physiological and molecular responses, a critical requirement for plant survival as sessile organisms, Phytohormones act either at their site of synthesis or elsewhere in plants following their transport (AL-Taey, 2017), On the other hand, phytohormones maybe increased the antioxidants repress free radical responses and may consequently ensure cells against oxidative harm (Al-Taey, *et al.*, 2018).

Arginine is an important amino acid that has a role in stress tolerant due to its importance in many physiological processes. Arginine takes place in proteins, proline, polyamines biosynthesis, osmotic potential, stomatal activity and vegetative growth (Velikova *et al.*, 2000; Abu Jadallah, 2010; EL- Bassiouny *et al.,* 2008).

This study aims to study the arginine role in improving the tomato plant growth under drought stress.

Materials and Methods

The experiment was carried out in the green house

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of Diyala Agriculture Department / Plant Production Section / Baquba Agricultural Nursery during winter season 2018 in a Sandy clay loam soil. (Table 1) shows some physical and chemical properties of the soil experiment. A factorial experiment with three replicates and Randomized Complete Block Design was carried out. The soil was plowed and divided into terraces with widths of 80 cm with a distance of 60 cm between terrace and the other. Fertigation with NPK (20:20:20) and micro elements fertilizer using T-type drip irrigation system was used. On 30/10/2017 MAJIDA tomato cultivation seedlings were planted. The distance between seedlings was 50 cm.

Table 1: Some chemical and physical properties of the soil experiment site.

Sandy clay loam	Texture	
6.36	1:1 EC (dsm^{-1})	
7.72	pH	
0.89	O.M%	
161.70	$CaCo_3 g.kg^{-1}$	
8.40	$mgkg^{-1}$	Nitrogen
32.94		Phosphorus
350.47		Potassium

The experiment included two stress levels S_1 (daily irrigation for 7 minutes) and S_2 (daily irrigation for 14 minutes), three levels of arginine A_1 (using water only), A_2 (using 1000 mg l^{-1} and A_3 using 2000 mg l^{-1}). Plants were sprayed with arginine on 7/12/2017, 14/12/2017, 21/12/2017 and 28/12/2017 using a mechanical spry. The total concentration of chlorophyll was estimated based on (Goodwin, 1965). The total carbohydrates as reported in (Joslyn, 1970) and Proline according to the method Bates (Bates, *et al.*, 1973). The plant product mean was estimated by applying the following equation.

$$\text{Plant yield} = \frac{\text{total experimental unit yield}}{\text{number of experimental unit plants}}$$

Data were statistically analyzed using SAS software and compared using Duncan's multiple range test.

Results and Discussion

Chlorophyll Concentration

Results in table 2 showed a significant effect of drought stress on the reduction of the chlorophyll by 16.18%. The lowest construction was 2.73 mg g^{-1} at the first stress level and increased to 2.91 mg g^{-1} at the second stress level. The decreased in chlorophyll construction can due to the lack of water in the guard cells, which leads to partial closure of the stomata, causing inhibition of photosynthesis and chlorophyll construction, increasing the activity of Chlorophyllase enzyme, as well as its oxidation by free radicals (Lushhack and Semchyshy, 2012).

Table 2: Effect of Drought Stress , Arginine and their Interaction on Total Chlorophyll Concentration mg g^{-1}.

Arginine mgl^{-1}		Drought stress		Arginine Effect average
		S_1	S_2	
A_1	0	2.08 b	2.12 b	2.10 b
A_2	1000	2.56 ab	2.94 ab	2.75 ab
A_3	2000	3.56 a	3.67 a	3.62 a
drought stress average		2.73 b	2.91 a	

Foliar application of arginine showed a significant increase in total chlorophyll by 72.38%. Treatment A_3 the highest value 3.62 mg g^{-1} while treatment A_2 was 2.75 mg g^{-1} and the lowest treatment A_1 2.10 mg g^{-1}. This can be attributed to the fact that arginine is an important nitrogen source for the formation of chlorophyll (EL- Hammady, 1999) Interaction between drought stress and arginine showed a significant effects on the chlorophyll concentration in tomato leaves. The chlorophyll concentration increased from 2.08 mg g^{-1} at A_1S_1 To 3.67 mg g^{-1}at S_2A_3 and 76.44%

Carbohydrates

Table 3 showed that drought stress due to a significant increase in carbohydrate concentration by 14.87% at 18.02 mg gm^{-1} at the second stress level S_2 and increased to 20.70 mg gm^{-1} at the first stress level S_1 can be attributed to adaptation to stress conditions where plants work on Increase the concentration of carbohydrates and other compounds where these compounds play an important role in Osmoregulation (Gill, and Tuteja, 2010).

Foliar application of arginine resulted in a significant increase of 28.88%, where it reached 17.03 mg gm^{-1} at the A_1 control coefficient and increased to 21.93 mg gm^{-1} at control coefficient A_3 reaching 19.21 mg gm^{-1}. This can be attributed to the role of arginine in increasing the leaf content of chlorophyll The efficiency of photosynthesis and carbohydrate production (EL-Hammady, 1999).

Interaction between drought stress and arginine showed a significant effects on the carbohydrate concentration in tomato leaves. maximum value of 23.44 mg gm^{-1} at S_1A_3 and the lowest value at treatment S_2A_1 was 15.69 mg gm^{-1}.

Proline

(Table 4) showed that drought stress caused a

Table 3: Effect of drought stress ,Arginine and their interaction on carbohydrates mg gm^{-1}.

Arginine mgl^{-1}		Drought stress		Arginine Effect average
		S_1	S_2	
A_1	0	18.36 b	15.69 c	17.03 c
A_2	1000	20.29 ab	17.94 b	19.12 b
A_3	2000	23.44 a	20.42 ab	21.93 a
drought stress average		20.70a	18.02 b	

significant increase in proline concentration, with an increase of 6.71%. Its concentration increased from 1.34 mg gm^{-1} at the second stress level S_2 to 1.43 mg gm^{-1} at the first stress level S_1. Proline increasing can be due to the degradation of protein and accumulation of free amino acids including Proline under drought stress conditions especially in roots and leaves (Tan and liang, 2006).

Foliar application of arginine resulted in a significant increase in proline concentration by 86.45%. The concentration of proline in the leaves increased from 0.96 mg gm^{-1} at A_1 to 1.79 mg gm^{-1} at A_3 and 1.42 mg gm^{-1} at A_2. This can be due to the role of arginine as a precursor for synthesis of proline (Ahmed, 1984). Proline accumulation helps to reduce the intracellular water potential, which improves the ability of the plant to withdraw water from soil (Zhu, 2002).

Table 4: Effect of Drought Stress , Arginine and their Interaction in Proline concentration (mg-[1] mg of fresh weight).

Arginine mgl^{-1}		Drought stress		Arginine Effect average
		S_1	S_2	
A_1	0	1.02 b	0.90 b	0.96 b
A_2	1000	1.47 a	1.37 b	1.42 ab
A_3	2000	1.82 a	1.75 a	1.79 a
drought stress average		1.43b	1.34a	

Interaction between drought stress and arginine showed a significant effects on the mean concentration of proline in tomato leaves. S_2A_1 treatment recorded the lowest proline value 0.90 mg gm^{-1} while S_1A_3 recorded the highest proline value 1.82 mg gm^{-1}.

Yield

Results in table 5 showed a significant drought stress effect on the mean plant yield. In the first stress level S_1, the plant yield was 782.5 g $plant^{-1}$ compared with the second stress level S_2 which was 1114.8 g $plant^{-1}$. This can be due to the inhibition of photosynthesis , carbon fixation, phyto hormones changes, nutrients uptake, oxidative stress (Mohammed and Abdelwahed 2009)

Foliar application of arginine caused a significant increase in the plant yield about 31.75%. A_1 treatment was the lowest value of plant yield 820.5 g $plant^{-1}$, while A_3 was the highest value with 1081 g $plant^{-1}$. This can be due to the role of arginine in plant growth under drought stress as a plant growth promoter, takes place in proteins, proline, polyamines biosynthesis, osmotic potential, stomatal activity and growth (Velikova *et al*., 2000; Abu Jadallah, 2010, EL- Bassiouny, 2008).

Table 5: Effect of Drought Stress , Arginine Levels and their Interaction in Plant yield g $plant^{-1}$.

Arginine mgl^{-1}		Drought stress		Arginine Effect average
		S_1	S_2	
A_1	0	672.7c	986.2 b	820.5b
A_2	1000	764.2 bc	1124.7 ab	944.5 ab
A_3	2000	910.4 b	1251.5 a	1081 a
drought stress average		782.5 b	1114.8 a	

Interaction between drought stress and arginine showed a significant effects on the plant yield. S_1A_1 treatment was the lowest value 672.7 g $plant^{-1}$, while S_2A_3 was the highest value reaching 1251.5 g $plant^{-1}$ with an increase of 86.04%.

Conclusion

1. The exposure of plant to drought stress reduce some physiological characteristics (chlorophyll) and the yield characterizes (plant yield). but led to occur significant increase in the some physiological characteristics (carbohydrates & proline).
2. The spraying of arginine amino acid in the concentration of 2000 mg l^{-1} was be positive effect in the decreased the damage effect of water stress because of it is work on increasing the physiological characterizes which positively reflected of the increased the plant yield..

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