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Effects of salinity stress on growth and yield of two varieties of eggplant under greenhouse conditions

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ABSTRACT

The study was aimed at finding out the performance of growth and yield of two cultivars (Threa and Barcelone) of eggplant grown under four salinity stress levels of electrical conductivities (control, 4, 8 and 12 Ec (dS/m), which were considered treatments of stress, under greenhouse conditions. Tap water as a control management was exploited, altogether managements were given to the plants at the first day of removing and continued during the whole growing season. Our results demonstrated that salt irrigation had an unfavourable effect on plant growth and yield. Also it was observed that the effect of increasing irrigation water salinity lowered in most of the traits. The study also indicated that Threa was sensitive to salt stress. Phenotypic data of plant height, leaf number, branches number, leaf area, shoot dry weight, average of fruit number, average of fruit weight and total fruit harvest showed high decrease under 8 and 12 Ec (dS/m) under salt stress. The highest level in proline (mcg/g) and root dry weight (g) under increasing irrigation water salinity recorded the highest rate (7.81 and 141.89, respectively), with Threa variety under salinity stress level 12 Ec (dS/m).

Key words : Eggplant (*Solanum melongena* L.), greenhouse, irrigation, salinity, stress, yield

INTRODUCTION

Eggplant (*Solanum melongena* L.) is well regarded among the vegetables progressively required by trades, whose demand for nutrition with potential health promoting effects, such as disease prevention is escalating (Borang *et al.,* 2017). Interestingly, it is said that eggplant fruits associate good nutritional value and therapeutic properties (Akinci *et al.,* 2004). In 2008, about 1.96 million ha were devoted for *S. melongena* L. agriculture international (FAO, 2010), somewhat main difficulties concerning water, properties and the reproduction in soil and water salinization appeared (Shrivastava and Kumar, 2015), the salinity represented an important limitation in the progress of modern agriculture (Suraj Kala, 2017). In some studies, United Nations (UN) specify 50% of the irrigated land is salinized. The salinity is effected on arid or semi-arid land, the precipitation still not enough and the water sources are also unusual due to the needs of water (Lamsal *et al.,* 1999; Al-Taey, 2018), high saline environments cause osmotic stress due to the difficulties in absorbing water from the soil and ion toxicity that can negatively affect the growth of many plants (Al-Taey and Majid, 2018). The water value reduces the per cent of the solely, the measureable data on crop salt tolerance occurs finished 130 crop lessons, also numerous vegetables which absence definitive data. Correct arrangement of irrigation is important for exploiting crop construction, while saving water and ensuring irrigation systems are naturally and carefully workable. Accurate development needs good information of crop tolerance to the value of salinity, water's need, the characteristics, and irrigation techniques (Chartzoulakis *et al.,* 1995). The plant prediction is related with water requirement and it's very important for planning the irrigations. Significant study is related to the growth of these models for crop and the growing period (Ouda *et al.,* 2006; Ali Ünlükara, 2008). Yurtseven *et al.* (2005) (prepared irrigated system for tomato with four levels of the salinity (0.25, 2.5, 5.0 and 10 dS/m) and the team decided that salinity increasing levels produced decrease in the consumption of the water. The difference in the tolerance is connected to the varieties and to the environmental situations,

because of diverse effects of salt on growth and harvest of eggplant, that study to evaluate the effects of stress on morphological, fruit parameters, growth, harvest and chemical of two varieties of *S. melogena* L. under greenhouse conditions.

MATERIALS AND METHODS

This study was conducted during season of 2016 in suwaira/visit of Iraq to evaluate performance of growth and yield of two cultivars (Threa and Barcelone) of *S. melogena* L. grown under four salinity stress levels of electrical conductivities (control, 4, 8 and 12 Ec (dS/m), which were considered treatments of stress. An experiment was carried out in greenhouse conditions. Seedlings (12-15 cm in length with 4-5 leaves) were produced with compound fertilizer (NPK) (20 : 20 : 20). The experiments were performed under completely randomized design (CRD) with three replications per treatment and nine seedlings. Relation of calcium chloride and sodium chloride was correspondingly diluted in water to make the stock resolution. Treatment solutions were made by adding stock solution to tap water until the desired salinity levels were achieved. Totally interpretations were detailed by an EC meter (Milwaukee SPEM500). The EC of the irrigated water continuously and gradually increased until each desired salinity level was achieved 4 Ec (dS/m), 8 Ec (dS/m) and 12 Ec with control. When all the untried plants were getting their selected salinity level, totally managements were irrigated every two days to the field capacity for the full period (Emad *et al.,* 2016).

Data Collection

Observations were carried out after the end of the season for seedlings of treating, 10 morphological characteristics measurements of net rates took reading at random locations in the plants, were recorded for each treatment used for the experiment, plant height (cm), leaf number, number of branches, leaf area (mm^2), dry weight of the shoot, proline the ratio of amino acid proline was estimated using the paper chromatographic according to method on 440 nm (Harborne, 1973), root dry weight (g), average of fruit number, average of fruit weight (g) and total fruit yield (kg).

Statistical Analysis

Data were analyzed by using the Statistical Analysis System program package (SAS, 2010) for three samples in each test. The data were expressed by mean±SEm, variance (ANOVA), and test significance of differences at $P<0.05$.

RESULTS AND DISCUSSION

The statistical analysis of data (Table 1) regarding the morphological was significant among varieties in the plant height, leaf number, branches number, leaf area and shoot dry weight. In this regard, plant height was significantly different among the two cultivars

Table 1. The effect of salinity on certain morphological characteristics of two eggplant varieties

Varieties	Ec (dS/m)	Plant height (cm)	Leaf number	Branches number	Leaf area (cm^2)	Shoot dry weight (g)
Barcelone	0	89.61a	65.32a	6.21a	3655.21a	151.22a
	4	71.40b	51.76b	4.98a	3211.43b	146.56b
	8	44.73bc	43.72c	3.88ab	2465.16c	134.41bc
	12	39.81c	38.30d	2.90b	2352.02d	132.78c
Threa	0	90.20a	69.22a	5.98a	3487.45a	152.81a
	4	77.43b	54.87ab	4.84a	3176.10b	147.51b
	8	41.91c	41.31c	3.91ab	2922.81c	135.90bc
	12	35.66c	36.66d	2.32b	2381.51d	131.76c
Average of varieties						
Barcelone		61.38a	49.77a	4.49a	2920.95a	141.24a
Threa		61.30a	50.51a	4.28a	2991.96a	141.99a
Ec (dS/m)						
0		89.90a	67.27a	6.09a	3571.33a	152.01a
4		74.41b	53.31b	4.91b	3193.76b	147.03b
8		43.32c	42.51c	3.89ab	2693.98bc	135.15ab
12		37.73c	37.48d	2.61c	2366.76c	132.27c

under irrigation water salinity. The plant height tended to decline as concentrations of salt irrigation water increased. The highest reduction in plant height under 12 Ec (dS/m) was 35.66 with Threa variety and Barcelone variety recorded 39.81 under 12 Ec (dS/m), as compared with control. Under higher Ec (dS/m) treatment, Threa variety gave highest plant height (90.20 cm) with control. Furthermore, salt irrigation had effect on leaf number under 12 Ec (dS/m) which resulted in the maximum loss (38.30 and 36.66) of varieties Barcelone and Threa, respectively. Moreover, Threa variety recorded the highest leaf number (69.22) at control. Table 1 shows that treating eggplant with a salt irrigation supply caused a significant decrease in branches numbes for all of the treatments recording the lowest rate (2.32) with Threa compared with the control recorded the highest rate (6.21 and 5.98) in Barcelone and Threa, respectively. On the other hand, variety Barcelone gave lowest rate of leaf area (2352.02), relative to the control the highest area (3655.21). Results showed (Table 1) that varieties Barcelone and Threa recorded highest average in the shoot dry weight (g) with control (151.22 and 152.81, respectively). Whereas variety Threa recorded lower rate (131.76).

Developing characters related with salt stress replies were significant to quantifying plant version devices to salinity stress (Blum, 1996). The considerable variances of plant height, leaf, branches and shoot entire dry between varieties and managements at the finish of the research were devoted to diverse and altered plant growth and physiological responses of the cultivars to the salinity levels throughout the research. Further research revealed that it was because the primary metabolite resulting from photosynthesis was used more to support the formation of vegetative organs of plants at the end of the vegetative phase, especially in the enlarged stems and leaves. Based on the known statement that the plant response to stress will provide a more significant impact on the broad parameters of the leaf and stem diameter these results are consistent with those of Asghari (2009) and Al-Taey *et al.* (2018). Based on the research that has been done on morphological and physiological responses in plants of eggplant (*Solanum melongena* L.) to drought and salt can be concluded that the response of plant morphological eggplant in the vegetative stage was influenced by four levels of drought stress with the watering interval of 3, 6, 9 and 12 days. Simultaneously, the effect of drought and salt on plant morphological eggplant (*Solanum melongena* L.) in the vegetative phase caused deterioration wide the age of 6, 8 and 10 weeks after treatment. The decrease in growth of stem diameter was at 2, 3, 4, 5, 6 and 7 weeks after treatment, as well as a decrease in leaf area growth was at 3, 4 and 7 weeks after treatments (Rizky Nanda Kurnia Ilahi *et al.,* 2017).

Chemical, Root and Yield of Eggplant

The averages of fruit parameters including proline, root dry weight, average of fruit number, average of fruit weight and total fruit yield for all salt irrigation treatments during periods of harvesting are shown in Table 2. The crops needed to synthesize compatible plant solutes such as proline in the cytosol. The proline was resolute and seemed to be related to the scale class of salt stress. Results from test indicated that the period of stress had a important overall effect on proline recorded the highest (7.81) with varieties under 12 Ec (dS/m), compared the control (2.78) in Barcelone variety. This buildup of osmolytes especially that of proline was the common singularity in plants. Besides its role as an osmolyte, proline contributed to scavenging ROS, stabilizing subcellular structures, modulating cell redox homeostasis, supplying energy and functioning as a signal. Proline accumulation is a common response to salt stress in plant, the extent of its accumulation varies between tolerant and sensitive genotypes. Indeed, our findings revealed the proline accumulation increased greatly inside the accepting varieties, mainly in leaves and when likened to the most sensitive genotype (Cano *et al.*, 1998). The results indicated significant progress in fresh weight of root dry weight in eggplant plantlets under 12 Ec. For this, effects illustrated an important growth in average root dry weight gave highest rate (141.89 g) with Threa, while Barcelone recorded (130.22 g) in the control. Root growth is the most indicative limitation for salt. Roots are more subtle to stress than the other plant parts, the only effect of treatment was the higher root dry weight in crops irrigated with 3.0 and 5.0 dS/m. Most importantly our effects indicated

Table 2. The effect of salinity on chemical, root and yield of eggplant varieties

Varieties	Ec (dS/m)	Proline (m cg/g)	Root dry weight (g)	Average of fruit number	Average of fruit weight (g)	Total fruit yield (kg)
Barcelone	0	2.78c	130.22c	13.54a	128.59a	3.26a
	4	3.21ab	129.95ab	11.65b	125.64b	2.45b
	8	5.76b	135.87b	10.72ab	122.56ab	2.32b
	12	6.94a	140.76a	8.99c	120.42c	1.78ab
Threa	0	3.21ab	131.57c	13.98a	127.99a	3.01a
	4	3.98ab	130.83c	10.87b	124.89b	2.21b
	8	5.81b	139.97b	8.49ab	119.68ab	1.99ab
	12	7.81a	141.89a	8.10ab	116.49c	1.89ab
Average of varieties						
Barcelone	4.67b	134.20b	11.23a	124.30a	2.45a	
Threa	5.20a	136.06a	10.36a	122.26b	2.27a	
Average Ec (dS/m)						
0	2.99c	130.89ab	13.76a	128.29a	3.13a	
4	3.59ab	130.39ab	11.26b	125.26b	2.33b	
8	5.78b	137.92b	9.60ab	121.12ab	2.15b	
12	7.37a	141.32a	8.54c	118.45c	1.83c	

the high salinity levels which may actually alter the partitioning pattern of dry preferring investment in root (Chartzoulakis *et al.*, 1995). Maintenance of root development throughout physiological deficiency is an obvious improvement to maintain an adequate water source, the salt stress had a negative effect on fruit number in 12 Ec which resulted in the maximum decrease (8.10) with Threa, in contrast with control which had the highest rate (13.98).

Simultaneously, the average of fruit weight at 12 Ec (dS/m) resulted in the maximum lessening (116.49 with Threa (*S. melogena* L.), the control recorded (128.59) with Barcelone. In the same way, the reduction magnitude was positively correlated with the saline irrigation waters which recorded less rate of total fruit yield (1.78 kg) to control recorded the highest total fruit yield (3.26 kg) with Barcelone. In this regard, also the lowest value of fruit yield (1.89 kg) under high concentration 12 Ec (dS/m) was recorded at Barcelone variety. Some researchers inferred that tomato harvest decrease was due to lessening in number of fruits fashioned. The number of tomato fruits/ plant depended on the number of trusses (Cuartero and Fernandez, 1999). In this matter, the tomato cultivars of Tainan asven no. 19, Hu alien asveg no. 21 and Taiwan Seed asveg no. 22 under 150 mm NaCl stress condition showed 73, 83.3 and 79.3% in number of marketable fruits per plant and 59, 66.4 and 61.4% in fruit set, respectively, less than those in the 0 mM NaCl condition (Liu *et al.*, 2014). Additionally, Magan *et al.* (2008) established a threshold value of 4.4 dS/m and a reduction in eggplant (*S. melongena* L.) fruit number of 2.0% with an increase of 1 dS/m beyond the threshold. A previous study found that the effects of salt stress on physiological response of *S. melogena* L. fruits grew-up hydroponically in the greenhouse. Fruit growth level, water potential, osmotic potential and cuticle permeability reduced meaningfully in preserved fruit as compared to control fruit. Ber in *S. melogena* L. fruit became visible externally at the age of 19 DAF but internally black discolouration was found in the intercellular air space at least one week before i.e. in 12 DAF. Throughout this period, fruit growth amount was rapid and maximum growth rate was observed at 19 DAF in control fruits. Growth rate of treated fruits was found to weakening significantly after 14 DAF and it almost ended after 19 DAF (Hossain1 and Nonami, 2012). The proline and root dry weight substantially increased in both tested eggplant genotypes under high salinity. Therefore, the study elaborated that tolerant genotype showed positive enzymatic response against salinity stress heights.

CONCLUSION

As a matter of fact, these data provided a useful understanding of salt stress responses to some varieties of eggplant and facilitated to develop strategies for the creation of new variety with more tolerance of stress. More specifically, the increasing concentrations of salt irrigation water decreased vegetative growth and fruit

parameters; it led to decrease in fresh yield and total fresh yield. With an increase in the proportion of proline and root dry weight in plants, two genotypes (Barcelone and Threa) were screened and confirmed to be tolerant in growth and yield as evidenced by the morphological responses. More specifically, the maximum activity of the qualities was obtained in Barcelone (*S. melogena* L.), under saline irrigation waters, which surpassed Threa variety for most of the traits.

REFERENCES

Akinci, I. E., Akinci, S., Yilmaz, K. and Dikici, H. (2004). Response of eggplant varieties (*Solanum melongena*) to salinity in germination and seedling stages. *New Zealand J. Crop and Hortic. Sci.* **32** : 1993-2000.

Ali Ünlükara, Ahmet Kurunc, Duygu Gülüzar Semiz and Donald L. Suarez (2008). *Effects of Salinity on Eggplant* (*Solanum melongena* L.) *Growth and Evapotranspiration* **134** : 160-66.

Al-Taey, D. K. A. (2018). The role of GA and organic matter to reduce the salinity effect on growth and leaves contents of elements and antioxidant in pepper. *Plant Archive* **18** : 479-88.

Al-Taey, D. K. A. and Majid, Z. Z. (2018). The activity of antioxidants enzymes and NPK contents as affected by water qaulity, kinetin, bio and organic fertilization in lettuce (*Lactuca sativa* L.). *Iraqi J. Agric. Sci.* **49** : 506-18.

Al-Taey, D. K. A., Mijwel, A. K. and Al-Azawy, S. S. (2018). Study efficiency of poultry litter and kinetin in reduced effects of saline water in *Vicia faba*. *Res. J. Pharm. and Tech.* **11** : 294-300.

Asghari, M. T., Daneshian, J. and Farahani, H. A. (2009). Effects of drought stress and planting density on quantity and morphological characteristics of chicory (*Cichorium intybus* L.). *Asian J. Agric. Sci.* **1** : 12-14.

Blum, A. (1996). Crop responses to drought and interpretation of adaptation. *Plant Growth Regul.* **20** : 135-46.

Borang, S., Basar, E., Gab, T. and Kato, D. (2017). Status and economic potential of indigenous vegetables of Arunachal Pradesh. *Fmg. & Mngmt.* **2** : 114-18.

Chartzoulakis, K. I., Therios, N. M. and Noitsakis, B. (1995). Growth, ion content and photosynthetic performance of salt-stressed kiwifruit plants. *Irrigation Sci.* **16** : 23-28.

Cuartero, J. and Fernandez, M. R. (1999).Tomato and salinity. *Scientia Hort.* **78** : 83-125.

Emad, Y. Bsoul, Shorouq Jaradat, Salman Al-Kofahi, Ahmed A. Al-Hammouri and Rami Alkhatib (2016). Growth, water relation and physiological responses of three eggplant cultivars under different salinity levels. **9** : 123-30.

FAO (2010). *http://faostat.fao.org/site/567/default.aspx#ancor.*

Harborne, J. B. (1973). *Phytochemical Methods*. Chapman and Hall Ltd., London. pp. 49-188.

Lamsal, K., Paudyal, G. N. and Saeed, M. (1999). Model for assessing impact of salinity on soil water availability and crop yield. *Agric. Water Manage.* **41** : 57-70.

Liu, F. Y., Li, K. T. and Yang, W. J. (2014). Differential responses to short-term salinity stress of heat-tolerant cherry tomato cultivars grown at high temperature. *Hort. Environ. Biotechnol.* **55** : 79-90.

Hossain1, M. M. and Nonami, H. (2012). Effect of salt stress on physiological response of tomato fruit grown in hydroponic culture system. *Hort. Sci.* **39** : 26-32.

Magan, J. J., Gallardo, M., Thompson, R. B. and Lorenzo, P. (2008). Effects of salinity on fruit yield and quality of tomato grown in soil-less culture in greenhouses in Mediterranean climatic conditions. *Agric. Water Manage.* **95** : 1041-55.

Ouda, S. A., Khalil, F. A. and Tantawy, M. M. (2006). Predicting the impact of water stress on the yield of different maize hybrids. *Res. J. Agric. and Biol. Sci.* **2** : 369-74.

Rizky Nanda Kurnia Ilahi, Mayta Novaliza Isda and Rosmaina (2017). Vegetative growth responses to drought stress in eggplant. Received : 7 December 2017, Accepted : 27 Dec., Published online : 30 December 2017.

SAS (2010). *Statistical Analysis System, User's Guide. Statistical Version 9.1l edn.* SAS. Inst. Inc., Cary, N. C., USA.

Shrivastava, P. and Kumar, R. (2015). Soil salinity : A serious environmental issue and plant growth promoting bacteria as one of the tools for its alleviation. *Saudi J. Biol. Sci.* **22** : 123-31.

Suraj Kala (2017). Effect of NaCl stress on chlorophyll content of isabgol (*Plantago ovata* Forsk.) genotypes. *Res. Crops* **18** : 332-35.

Yurtseven, E., Kesmez, G. D. and U¨nlu¨kara, A. (2005). The effects of water salinity and potassium levels on yield, fruit quality and water consumption of a native Central Anatolian tomato species (*Lycopersicon esculentum*). *Agric. Water Manage.* **78** : 128-35.