Assessment of tomato genotypes against salinity on the basis of morphological and physiological parameters in hydroponic conditions

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Abstract: Salinity stress is the most serious environmental factors which badly effect the crop plants productivity. Salt stress effects various physiological and biochemical processes due to which the growth and development of the crop plants is affected. Salt tolerance genotypes need time to develop potential in crop through conventional and molecular breeding and get the healthy food all over the world. The experiment was compassed hydroponically in shade house where proper air, light and water system was handled. Six genotypes viz CLN- 2498- A, Black Cherry, BL-1176, PBLO- 017902, Nagina, CLN- 1621- L. Two replication of each genotype was used in different water tubs. In order to determine the salt to lerance genotype, application of NaCl was done in hydroponic medium. Three treatments (T0= Controlled, T1=150Mm NaCl, T2= 300Mm NaCl) was used in hydroponic system. For this purpose, Tomato genotypes were transplanted in water tubs each having capacity of 200 liters. Hoagland's solution was set in distilled water which was used to give nutrient to tomato genotypes. The data was recorded after 90 days of seedling transplantation for plant height, number of nodes, number of flowers, number of fruits, fresh and dry weight of root and shoot, TSS, transpiration, photosynthesis rate, internal CO 2 gas exchange and stomatal conductance. Analysis of variance of all the traits showed significant differences, which revealed that different genotypes showed variations against salinity stress. It was observed that the overall performance of genotype BL-1176 and CLN- 2498- A was significantly different from all other genotypes and performing good in 300mM NaCl concentrations for the most traits like number of flowers, number of fruits, fruit weight, dry weight of shoot and root. While the overall performance of Nagina, CLN - 1621- L and PB- LO- 017902 were badly affected by salinity stress and showed poor performance against number of fruits, number of flowers, fruit weight and dry weight of root and shoot.

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Key words: salinity, tomato, hydroponic

Introduction

Pakistan is primarily an agricultural country. Its system of development and economic development is affected by agriculture, which represents 20.9% of the country's GDP (Pakistan Economic Survey, 2014-2015). In Pakistan, after potato and onion (Khokhar, 2014), tomato is considered to be the third most important vegetable. From 2015 to 2016, the total area of tomato cultivation in Pakistan is about 523,000 hectares, and the total production is only 529,900 tonnes. The average yield of tomato crops in Pakistan is very little in comparison to the modern world, and the difference in this production is largely due to the inadequate use of technology and inputs poor production (Muhammad *et al*., 2017). Tomatoes (*Lycopersicon escultantum*) are one of the most important horticultural crops in the world. Tomato fruit is an important source of daily diet and the main components of antioxidants, minerals and vitamins (Dorais *et al*., 2005). Salinity stress limits the productivity of crops (Tahir *et al*., 2018; Safdar *et al*., 2019) and has adverse effects on germination, plant strength and crop yield (Mune and Examiner, 2008). Several studies have shown that high concentrations increase the size of fruit, fruit size and low performance, in contact with salt tomato plants (Mohammed *et al*., 1998) in their areas of root. According to the records, the total area of land affected by salt damage is approximately 830 million hectares (Martnez-Beltran and Manzur, 2005). In agricultural productivity, such irrigation-driven salinity and salinity is affected by the salinity of the type of soil, such as the dry "short term" (Rengasamy, 2006). Many areas of the world have to face the most severe soil problems, i.e., water extraction and salinity (Shafqat *et al*., 1998). Hydroponics is a plant development system that uses a nutrient-mineral solution instead of soil. The hydroponic system is used to improve the growth environment and to limit moisture and nutrient uncertainty. It helps save water and fertilizer, which improves the efficiency of crop water use. In addition, it can reduce the loss of salinity due to the release of pests and fertilizers (Zhang *et al*., 2016). However, with the loss of performance by reducing the weight of the fruit, due to the absence of saline stress on the root zone (rather than the number of fruits, Li *et al*., 2001). Due to the high osmotic pressure of the irrigation fluid, the moisture flow rate decreases and the moisture stress prevents the size of the fruit (Li *et al*, 2001, Mavrogianopoulos *et al*, 2002). The exact effect on salinity may depend on the sensitivity of species and environmental conditions (Karlberg *et al*., 2006). The destructive effect of salt stress on tomatoes is revealed by slow growth (Kamrani *et al*, 2013), fruit size and fruit yield (Bustomi Rosadi *et al*, 2014; Magna *et al*., 2008). Summary of Gamma *et al*. (2007) identified three mechanisms that affect the stress of plant salinity: 1) lack of water due to decreased water efficiency in the root zone; 2) Due to high concentrations of toxic Na + and Chlor-3, the effect is due to inhibition of transport and / or spread of imbalance. Examiner and Davenport (2003) also stated that high concentrations of Na + cause intrusion into plants and cause a series of metabolisms. In addition, it is generally accepted that the fruit quality of tomato plants grown under saline conditions is higher than that of non-saline tomato plants (Magn *et al*, 2008). Many varieties of tomatoes vary in response to some salt stress. In most crops, salinity has negative effects on crop yield, plant potency and germination. Salinity mainly affects the root zone of the plant and negatively affects the transport system of the plant. Many studies have reduced tomato growth, fruit size, and fruit yield when exposed to high levels of study (Munns and Examiner 2008). Salt-stressed plants reduced water potential three times compared to other stresses and caused ion imbalance and toxicity. Vegetable tomatoes are relatively salt-tolerant. Salt stress negatively affected germination rate, dry weight of shoots, and Na + /K + ratio in roots and shoots. Many genetic variations on salinity stress have been reported in tomato genotypes and these genotypes can be used in breeding programs (Singh *et al*., 2011).

This study set out to study the following goals:

- Investigate the effects of different levels of salt concentration on tomato germination under hydroponic conditions.
- Assess and select different genotypes that are more tolerant to salt stress.
- Study the morphological characteristics of different genotypes at different salinity levels.

Materials and methods

Table 1

Chemical Compound	Level A seedling to first fruit (g/1000liters)	Level B fruit set t0 harvest (g/1000liters)	Nutrient	Level A (ppm)	Level B (ppm)
Magnesuim sulfate (Epsom salts)	500	500	Mg	50	50
Monopotassium phosphate (0-22.5-28)	270	270	K	199	199
Potassium nitrate (13.75-0-36.9)	200	200	P	62	62
Potassium sulfate (0-0-43.3)	100	100	N	113	144
Calcium nitrate (15.5-0-0)	500	680	Ca	122	165

The research was conducted at green house, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The experiment was compassed hydroponically in shade house where proper air, light and water system was handled. Six genotypes viz CLN - 2498- A, Black Cherry, BL-1176, PBLO- 017902, Nagina, CLN- 1621- L. Two replication of each genotype was used in different water tubs. In order to determine the salt to lerance genotype, application of NaCl was done in hydroponic medium. Three treatments (T0= Controlled, T1= 150Mm NaCl, T2= 300Mm NaCl) was used in hydroponic system. For this purpose, Tomato genotypes were transplanted in water tubs each having capacity of 200 liters. Hoagland's solution was set in distilled water (Table 2), which was used to give nutrient to tomato genotypes. In water containers thermo - pole sheet was used for support to the plants. Tomato plants were raise in water by making small holes in thermo- pole sheet at base and fixed plants with foam in holes. Aeration pumps were used for aeration in water for plants. Medium were replaced every 3 weeks with Hoagland's solution to conserve the nutrients utilized by tomato genotypes. The PH of the hydroponic tubs maintained 6 to 6.5 by adding either NaOH or H2SO4. Since optimum PH is required for translocation of nutrients in plants. The data was recorded after 90 days of seedling transplantation for plant height, number of nodes, number of flowers, number of fruits, fresh and dry weight of root and shoot.

Preparion of micronutrient stock solution. Use 250ml of this stock in each 1000 liters of nutrient solution from table 2 (Jenson and Malter, 1905).

Fertilizer Salt	Grams of chemical in 450mL stock solution
Boric acid	7.5
Manganous chloride	6.75
Cupric chloride	0.37
Molybdenum trioxide	0.15
Zinc sulfate	1.18

Results and discussion

Plant Height

Statistical analysis exhibited significant differences among treatment and genotypes regarding plant height. Which means that genotypes performed differently in the stress and normal conditions. Table 3 revealed means performance of genotypes at salinity levels for plant height. According to the means genotype CLN-16212-L and Black cherry with maximum mean value 173.83 and 170.00 respectively considered as the best and genotype CLN -2498-A and BL-1176 having a minimum value of 127.00 and 123.00 respectively. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 1. indicated the interaction of the plant height means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 4.1 genotype CLN-1621-L and Black cherry represented performed best and BL-1176 and CLN-2498-A genotype performed as poor under different salt stress levels.

Table 3: Effect of salinity level on plant height (cm) of various genotypes of Tomato. Treatments

Genotypes	**Control**	**150 mM NaCl**	**300 mM NaCl**	**Means**
CLN-2498 A	93.5	137.6	139.6	123.57 F
Black Cherry	158.65	172	180.25	170.3 B
BL-1176	92.5	142	149.75	128.08 E
BP-LO-017902	151.75	154.5	174.5	160.25 C
Nagina	159.25	147.25	158.5	155 D
CLN-1621 L	172	171.25	179.5	174.25 A
Means	137.94 C	154.1 B	163.68 A	

Table 4: Effect of salinity level on number of nodes of various genotypes of Tomato. Treatments

Genotypes	**Control**	**150 mM NaCl**	**300 mM NaCl**	**Means**	
CLN-2498 A	17.5	22.5	23.5	21.167	C
Black Cherry	27.5	18.5	29.5	25.167	B
BL-1176	16.5	16.5	24.5	19.167	D
BP-LO-017902	25.5	26.5	25.5	25.833	B
Nagina	27.5	26.5	5.5	19.833	D
CLN-1621 L	30.5	32.5	30.5	31.167	A
Means	24.167 A	23.833 AB	23.167 B		

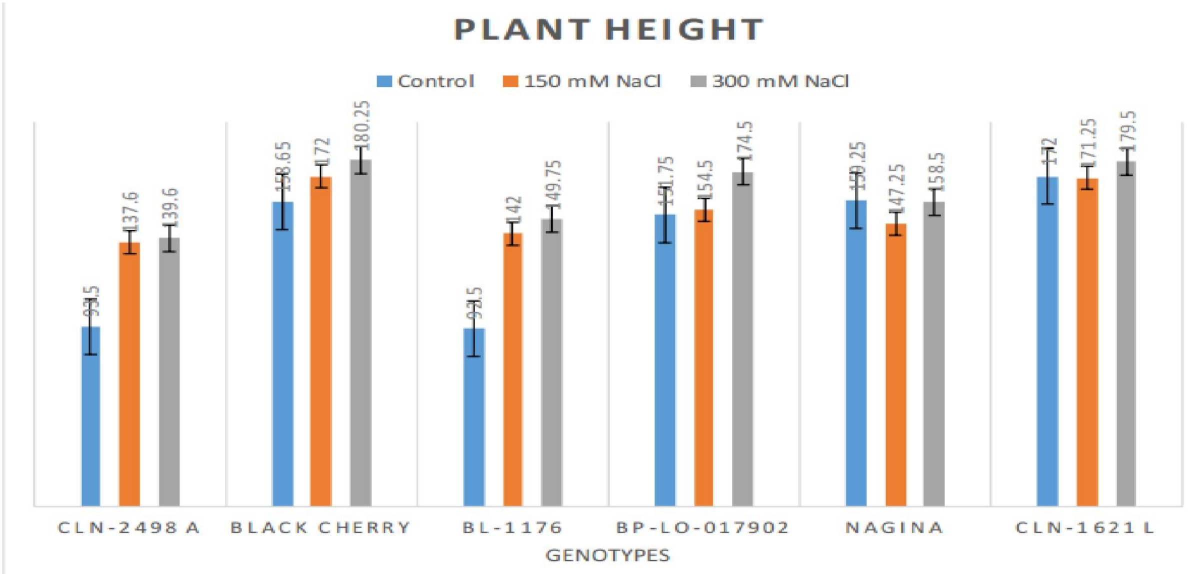

Figure 1: Effect of salinity level on plant height of various genotypes of Tomato. Bars represent standard error.

Number of nodes

Statistical analysis exhibited significant differences among treatment and genotypes regarding number of nodes. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 4 revealed means performance of genotypes at salinity levels for number of nodes. According to the means genotype CLN-1621-L with maximum mean value 30.667 considered as the best and genotype BL-1176 having a minimum value of 20.667. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 2 indicated the interaction of the number of nodes means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 4.2 genotype CLN-1621-L represented performed best and genotype BL-1176 performed as poor under different salt stress levels.

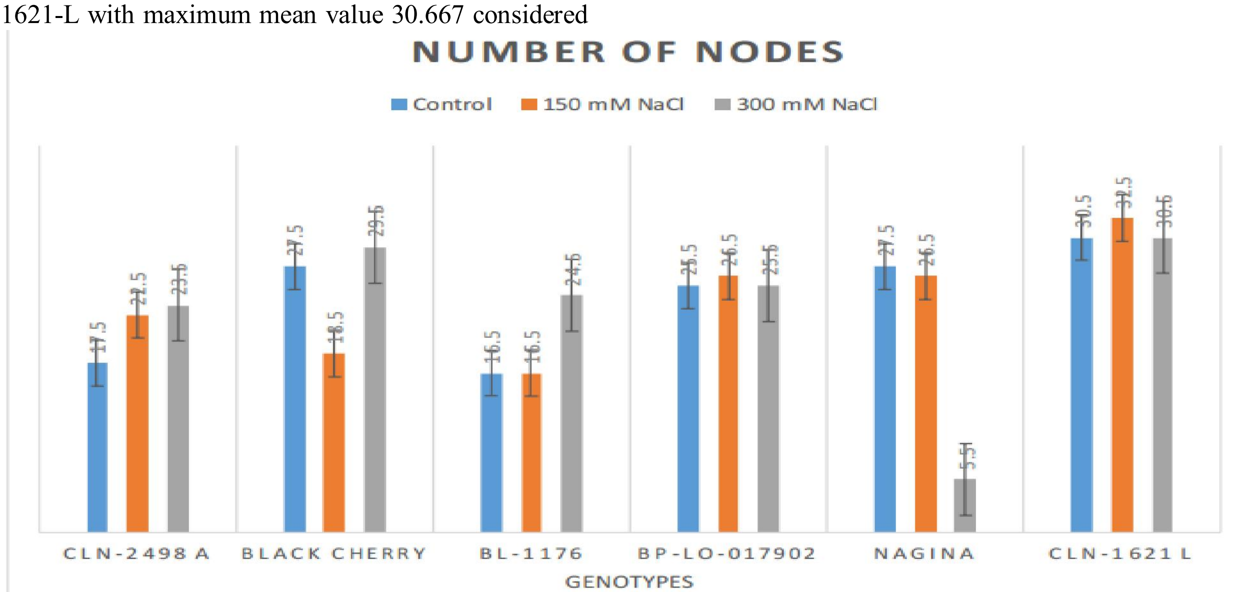

Figure 2: Effect of salinity level on number of nodes of various genotypes of Tomato. Bars represent standard error.

Number of flowers

Statistical analysis exhibited significant differences among treatment and genotypes regarding number of flowers. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 5 revealed means performance of genotypes at salinity levels for number of flowers. According to the means genotype BL-1178 with maximum mean value 28.333 considered as the best and genotype Nagina and PB-LO-017902 having a minimum value of 4.667 and 4.667 respectively. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 3 indicated the interaction of the plant number of flowers means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig.3 genotype BL-1176 represented performed best and genotype Nagina and PB-LO-017902 performed as poor under different salt stress levels.

Table 5: Effect of salinity level on number of flowers of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	12.5	14.5	12.5	13.167	C
Black Cherry	26.5	17.5	20.5	21.5 B	
BL-1176	27.5	25.5	33.5	28.833	A
BP-LO-017902	5.5	4.5	5.5	5.167	D
Nagina	8.5	2.5	4.5	5.167	D
CLN-1621 L	19.5	17.5	13.5	16.833	BC
Means	16.667 A	13.667 A	15 A		

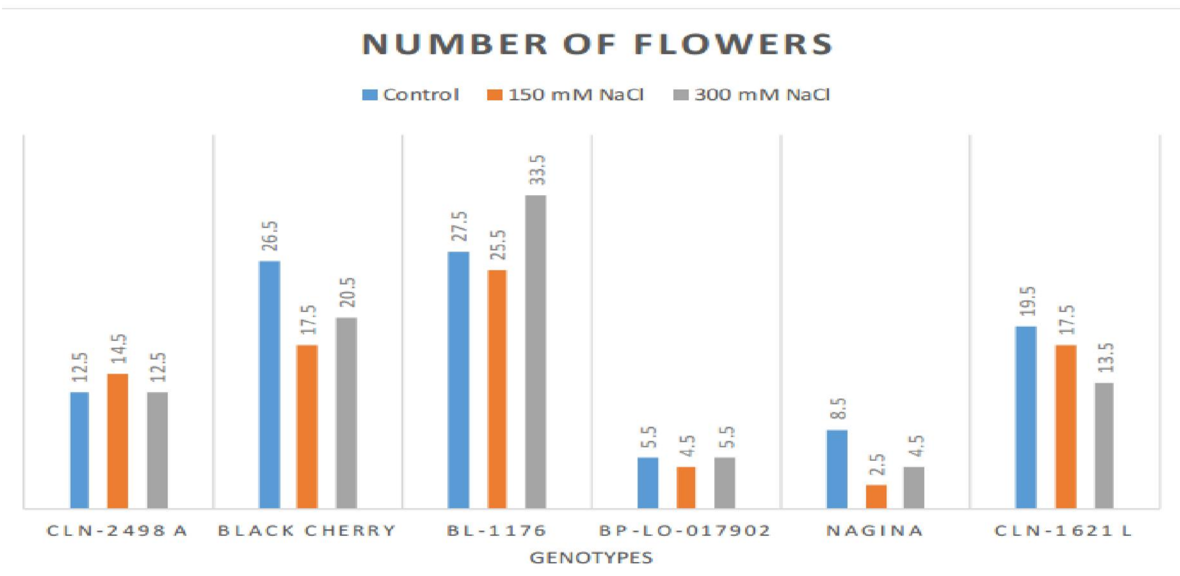

Figure 3: Effect of salinity level on number of flowers of various genotypes of Tomato. Bars represent standard error.

Table 6: Effect of salinity level on number of fruits of various genotypes of Tomato. Treatments

Genotypes	Control		150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	7.5		3.5	4.5	5.1667	B
Black Cherry	15.5		6.5	6.5	9.5 A	
BL-1176	10.5		5.5	10.5	8.8333	A
BP-LO-017902	3.5		1.5	0.5	1.8333	C
Nagina	0.5		0.5	0.5	0.5 D	
CLN-1621 L	6.5		8.5	3.5	6.1667	B
Means	7.3333	A	4.3333 B	4.3333 B		

Number of fruits

Statistical analysis exhibited significant differences among treatment and genotypes regarding number of fruits per plant which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 6 revealed means performance of genotypes at salinity levels for number of fruits. According to the means genotype BL-1176 with maximum mean value 9.877 considered as the best and genotype 4.555 having a minimum value of Nagina. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 4 indicated the interaction of the number of fruits means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 4.4 genotype BL-1176 performed best and genotype Nagina performed as poor under different salt stress levels.

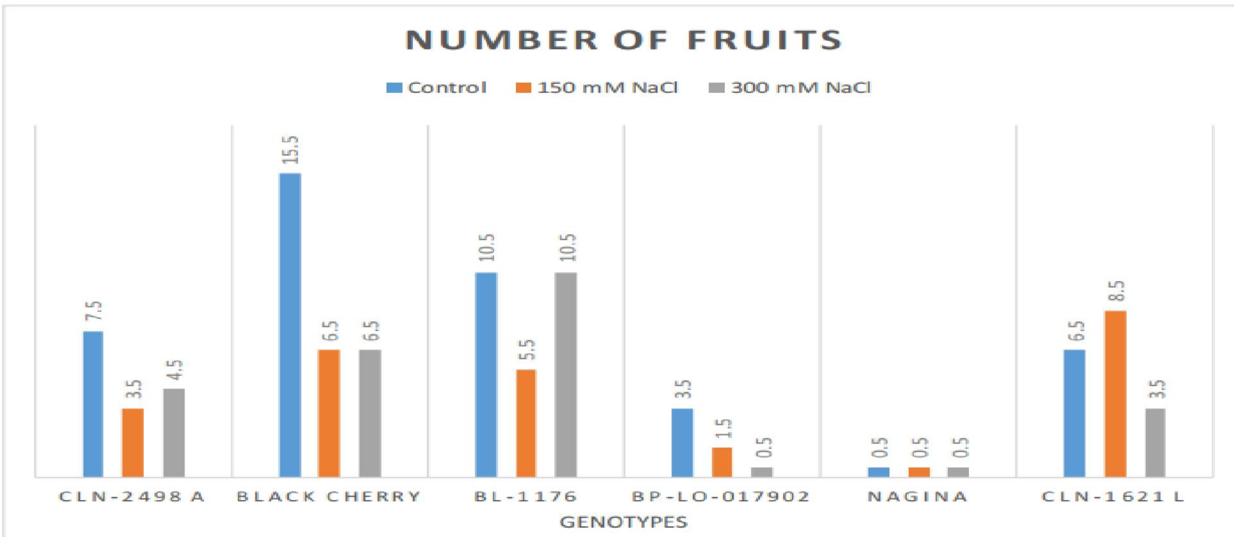

Figure 4: Effect of salinity level on number of fruits of various genotypes of Tomato. Bars represent standard error.

Fruit weight:

Statistical analysis exhibited significant differences among treatment and genotypes regarding fresh weight. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 7 revealed means performance of genotypes at salinity levels for fruit weight. According to the means genotype BL-1176 with maximum mean value 176.67 considered as the best and genotype PB-LO-017902 and angina having a minimum value of 40.00 and 5.33 respectively. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 5 indicated the interaction of the fruit weight means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 4.14 genotype BL-1176 represented performed best and genotype PB-LO-017902 and Nagina performed as poor under different salt stress levels.

Table 7: Effect of salinity level on fruit weight (g) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	70.5	211	136	139.17 B
Black Cherry	0	0	121	40.33 E
BL-1176	72.5	66.5	80.5	73.17 C
BP-LO-017902	10.5	0	126.5	45.67 D
Nagina	171.5	61	302	178.17 A
CLN-1621 L	0.5	0.5	16.5	5.83 F
Means	54.25 C	56.5 B	130.42 A	

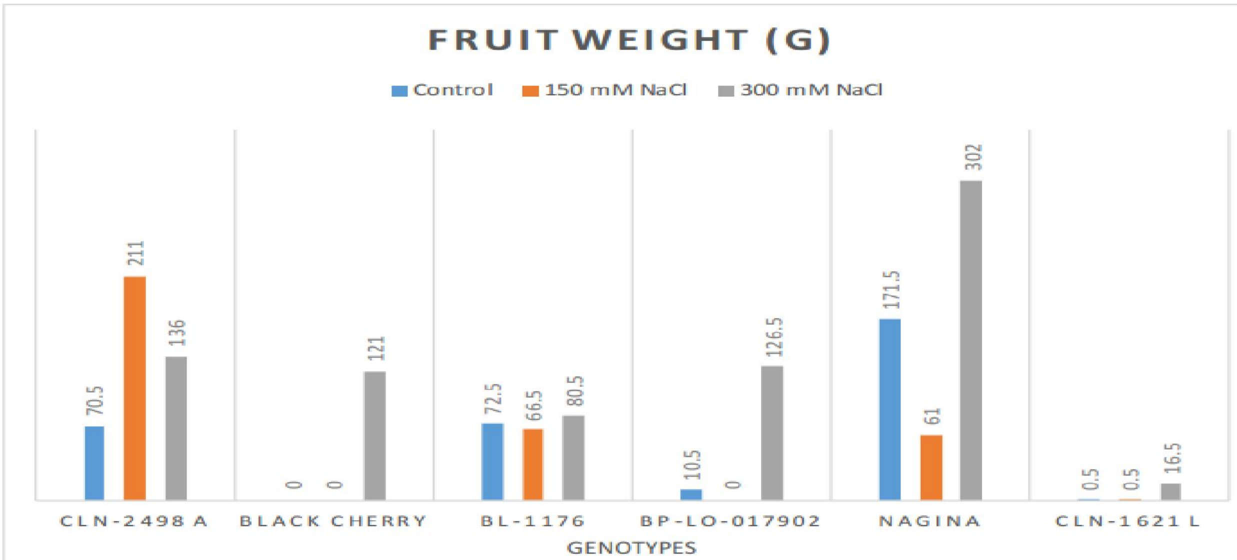

Figure 5: Effect of salinity level on fruit weight of various genotypes of Tomato. Bars represent standard error.

Fresh weight of shoot:

Statistical analysis exhibited significant differences among treatment and genotypes regarding fresh weight of shoot. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 8 revealed means performance of genotypes at salinity levels for fresh weight of shoot. According to the means genotype Black cherry with maximum mean value 873 considered as the best and genotype BL-1176 having a minimum value of 612. All six genotypes behaved in different manners. Overall results indicated that as salinity level increased, fresh shoot weight decreased. The table 8 indicated the interaction of the fresh weight shoot means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 6 genotype Black cherry represented performed best and genotype BL-1176 performed as poor under different salt stress levels.

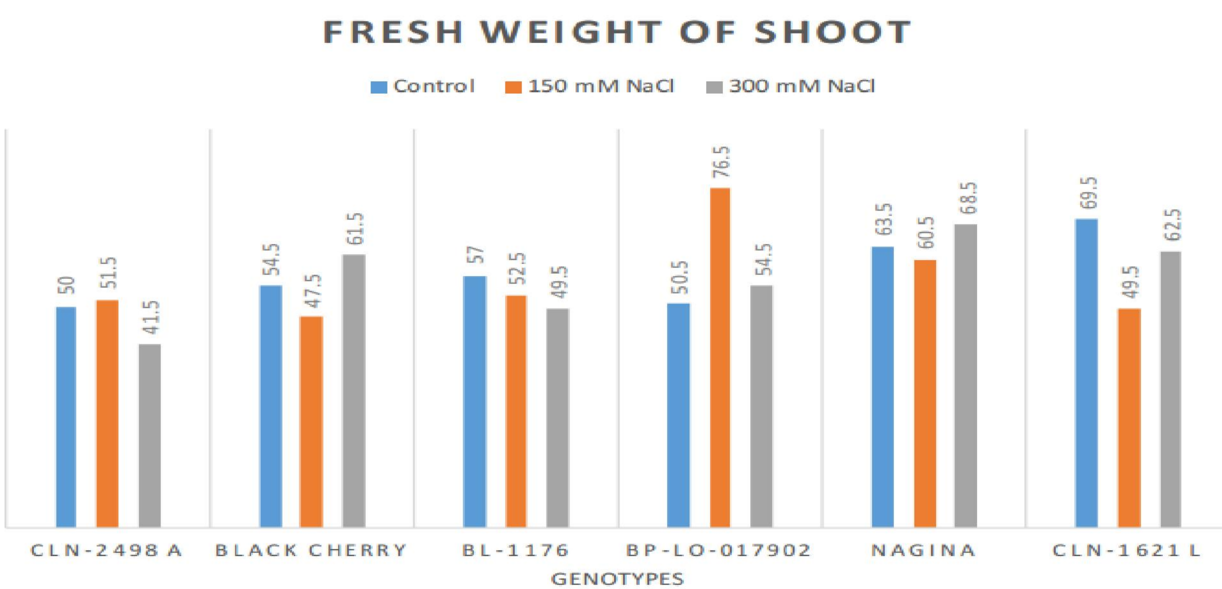

Figure 6: Effect of salinity level on fresh weight of shoot of various genotypes of Tomato. Bars represent standard error.

Table 8: Effect of salinity level on fresh weight of shoot (g) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	50	51.5	41.5	59.5 A	
Black Cherry	54.5	47.5	61.5	58.167	AB
BL-1176	57	52.5	49.5	57.833	B
BP-LO-017902	50.5	76.5	54.5	56.833	B
Nagina	63.5	60.5	68.5	54.833	C
CLN-1621 L	69.5	49.5	62.5	53.167	D
Means	62.333 A	56.75 B	51.083 C		

Fresh weight of root:

Statistical analysis exhibited significant differences among treatment and genotypes regarding fresh weight of root. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 9 revealed means performance of genotypes at salinity levels for fresh weight of root. According to the means genotype CLN-1621-L with maximum mean value 59.33 considered as the best and genotype BL-1176 having a minimum value of 45.667. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 7 genotype CLN-1621-L represented performed best and genotype BL-1176 performed as poor under different salt stress levels.

Table 9: Effect of salinity level on fresh weight of root (g) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	50	51.5	41.5	59.5 A	
Black Cherry	54.5	47.5	61.5	58.167	AB
BL-1176	57	52.5	49.5	57.833	B
BP-LO-017902	50.5	76.5	54.5	56.833	B
Nagina	63.5	60.5	68.5	54.833	C
CLN-1621 L	69.5	49.5	62.5	53.167	D
Means	62.333 A	56.75 B	51.083 C		

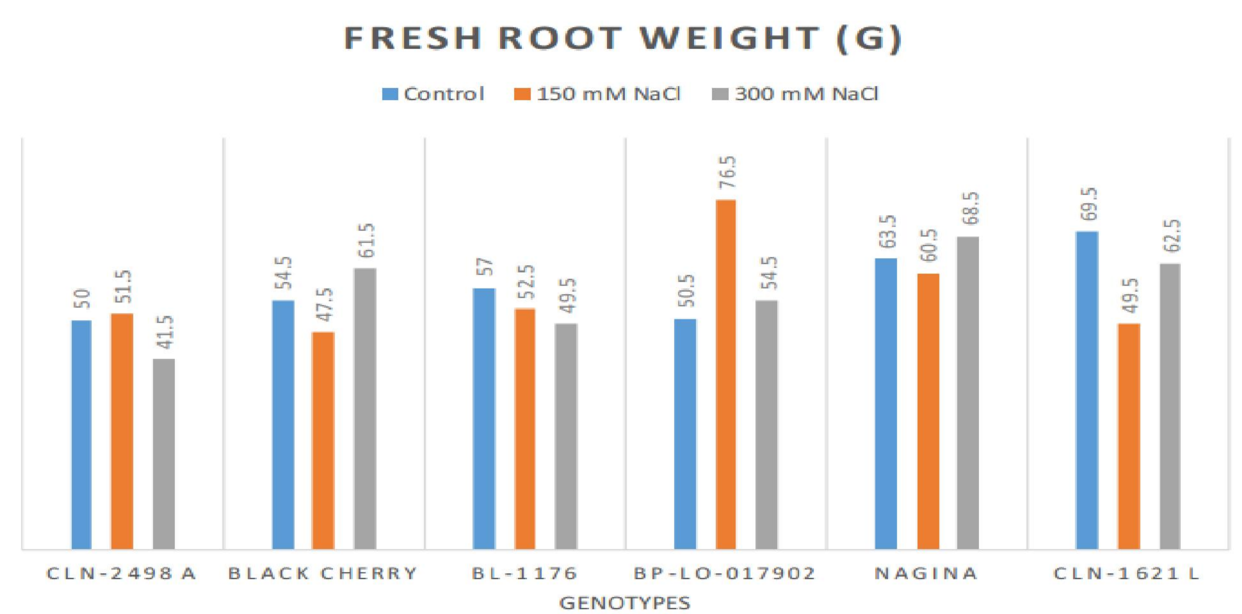

Figure 7: Effect of salinity level on fresh weight of root of various genotypes of Tomato. Bars represent standard error.

Dry weight of shoot:

Statistical analysis exhibited significant differences among treatment and genotypes regarding dry weight of shoot. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 10 revealed means performance of genotypes at different salinity levels for dry weight of shoot. According to the means genotype Black cherry with maximum mean value 100.00 considered as the best and genotype Nagina having a minimum value of 62. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 8. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 4.17 genotype 'Black cherry' represented performed best and genotype Nagina performed as poor under different salt stress levels.

Table 10: Effect of salinity level on dry weight of root (g) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	61.5	89.5	97.5	100.5 A
Black Cherry	72.5	69.5	77.5	86.17 B
BL-1176	97.5	97.5	85.5	81.5 C
BP-LO-017902	79.5	56.5	80.5	80.5 CD
Nagina	85.5	114.5	75.5	79.83 D
CLN-1621 L	87.5	61.5	83.5	62.5 E
Means	84.667 A	82.833 B	78 C	

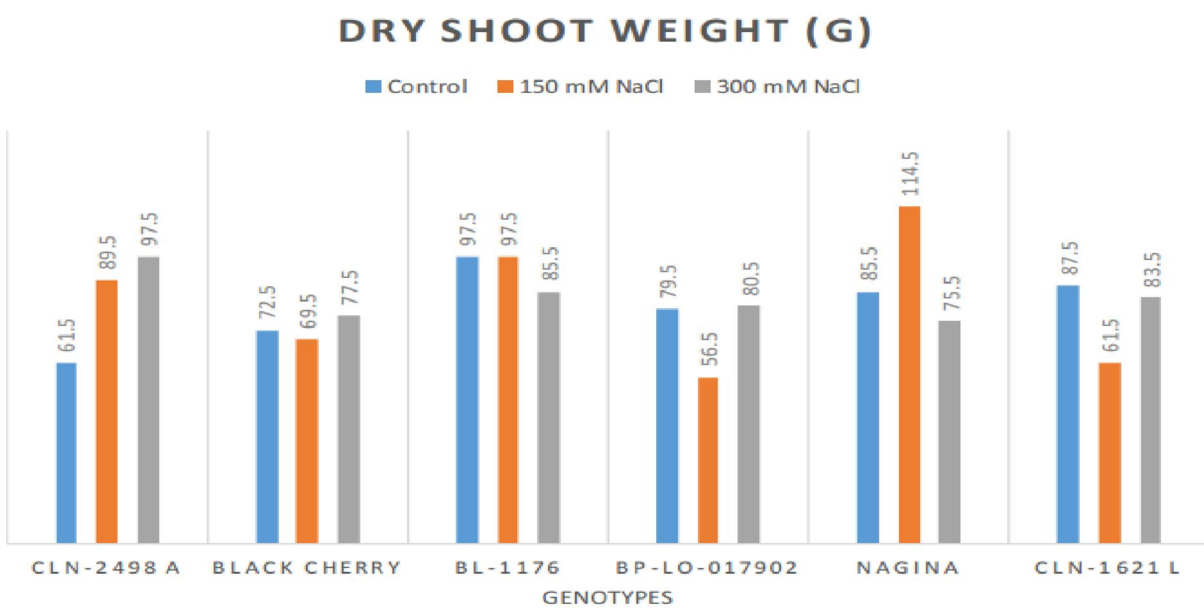

Figure 8: Effect of salinity level on dry weight of root of various genotypes of Tomato. Bars represent standard error.

Dry weight of root

Statistical analysis exhibited significant differences among treatment and genotypes regarding dry weight of root. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 11 revealed means performance of genotypes at salinity levels for dry weight of root. According to the means genotype CLN-2498-A with maximum mean value 16.667 considered as the best and genotype Nagina having a minimum value of 12.00. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig.9 indicated the interaction of the dry weight of root means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 9 genotype CLN-2498-L represented performed best and genotype Nagina performed as poor under different salt stress levels.

Table 11: Effect of salinity level on dry weight of root (g) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	13.5	11.25	10.5	16.917	A
Black Cherry	15.5	9.5	14.25	15.083	B
BL-1176	16.5	13.75	13.25	14.833	BC
BP-LO-017902	12.5	16.5	12.5	14.833	BC
Nagina	20.75	19.5	17.5	13.75 C	
CLN-1621 L	16.5	11.5	18.5	12.5 D	
Means	17.375 A	14.167 B	12.417 C		

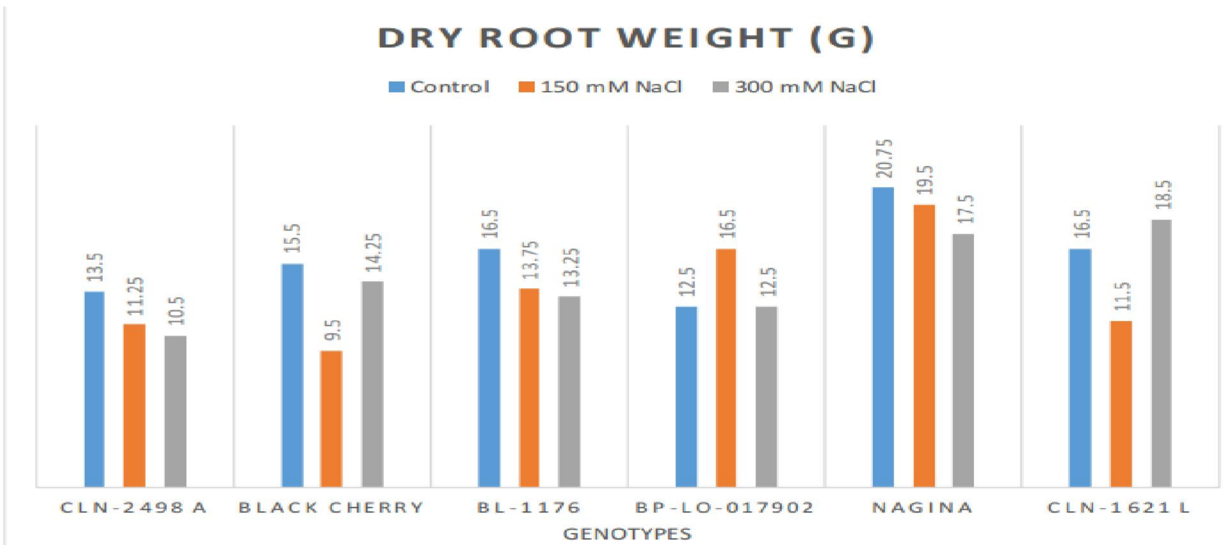

Figure 9: Effect of salinity level on dry weight of root of various genotypes of Tomato. Bars represent standard error.

TSS

Statistical analysis exhibited significant differences among treatment and genotypes regarding TSS of fruit. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 12 revealed means performance of genotypes at salinity levels for TSS of fruit. According to the means genotype CLN-2498-A and Black cherry with maximum mean value 8.778 and 8.70 respectively considered as the best and genotype CLN-1621-L having a minimum value of 7.5167. All six genotypes behaved in different manners. Fig. 10. indicated the interaction of the total soluble salts means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 10 genotype CLN-2498-A and Black cherry represented performed best and genotype CLN-1621-L performed as poor under different salt stress levels.

Table 12: Effect of salinity level on TSS (^{o}Brix) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	8.15	7.25	7.15	8.7883 A
Black Cherry	9.45	8.65	8.265	8.705 A
BL-1176	8.85	7.875	7.775	8.215 B
BP-LO-017902	7.605	10.085	8.425	8.1667 B
Nagina	8.535	8.375	7.735	7.87 BC
CLN-1621 L	8.96	7.4	7.25	7.5167 C
Means	8.5917 A	8.2725 B	7.7667 C	

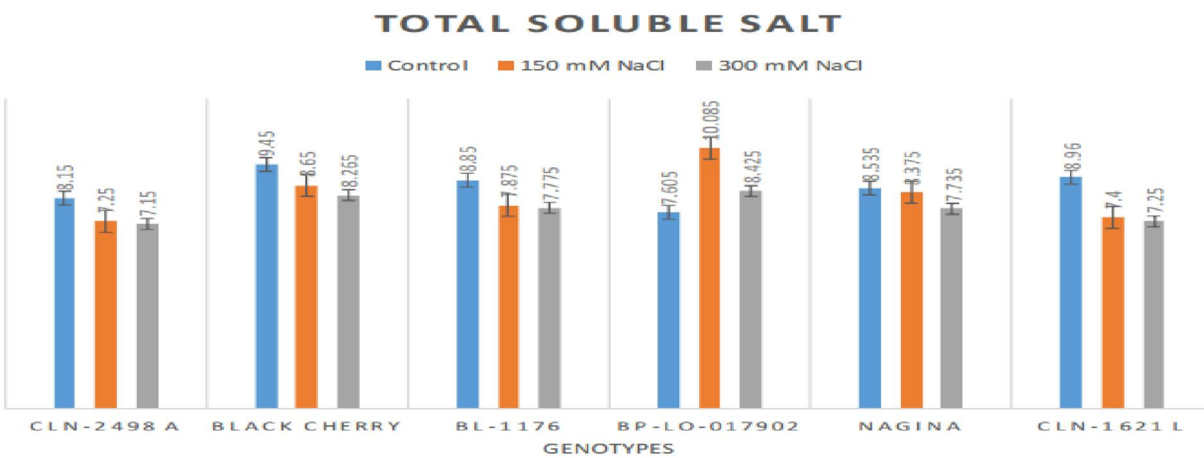

Figure 10: Effect of salinity level on TSS of various genotypes of Tomato. Bars represent standard error.

Photosynthetic rate:

Statistical analysis exhibited significant differences among treatment and genotypes regarding photosynthetic rate. Which means that genotypes performed differently in the stress and normal conditions. The non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 13 revealed means performance of genotypes at salinity levels for photosynthetic. According to the means genotype CLN-1621-L with maximum mean value 9.7367 considered as the best and genotype Black cherry having a minimum value of 4.1633. All six genotypes behaved in different manners. Fig. 11 indicated the interaction of the rate of photosynthesis means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 11 genotype CLN-1621 represented performed best and genotype Black cherry performed as poor under different salt stress levels.

Table 13 (b): Effect of salinity level on photosynthetic rate (µ ergs cm-2 sec-1) of various genotypes of Tomato.

Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	4.225	4.52	5.84	4.8617 E
Black Cherry	3.7	1.7	7.3	4.2333 F
BL-1176	6.2	7.5	6.54	6.7467 C
BP-LO-017902	4.45	5.725	8.5	6.225 D
Nagina	10.6	9.7	7.79	9.3633 B
CLN-1621 L	8.425	10.8	10.25	9.825 A
Means	6.2667 C	6.6575 B	7.7033 A	

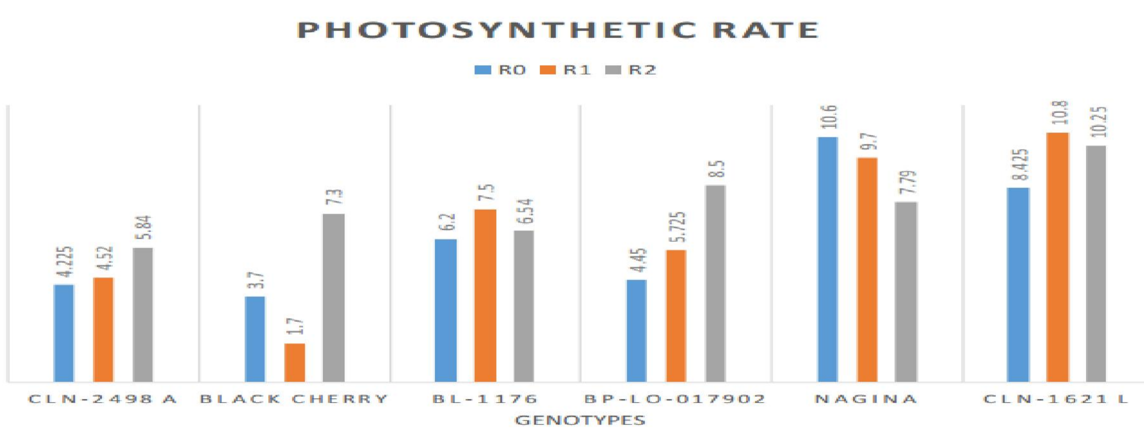

Figure 11: Effect of salinity level on photosynthetic rate of various genotypes of Tomato. Bars represent standard error.

Stomatal conductance:

Statistical analysis exhibited significant differences among treatment and genotypes regarding stomatal conductance. Which means that each genotype performed differently under stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 14 revealed means performance of genotypes at salinity levels for stomatal conductance. According to the means genotype Nagina with maximum mean value 0.0467 considered as the best and genotype CLN-2498-A having a minimum value of 0.0300. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 12 indicated the interaction of the stomatal conductance means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 12 genotype Nagina represented performed best and genotype CLN-2498-A performed as poor under different salt stress levels.

Table 14: Effect of salinity level on stomatal conductance (mmol m-2 sec-1) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	0.035	0.025	0.045	0.035 B
Black Cherry	0.06	0.045	0.025	0.0433 AB
BL-1176	0.045	0.065	0.035	0.0483 AB
BP-LO-017902	0.055	0.065	0.035	0.0517 A
Nagina	0.035	0.085	0.035	0.0517 A
CLN-1621 L	0.055	0.06	0.025	0.0467 AB
Means	0.0475 B	0.0575 A	0.0333 C	

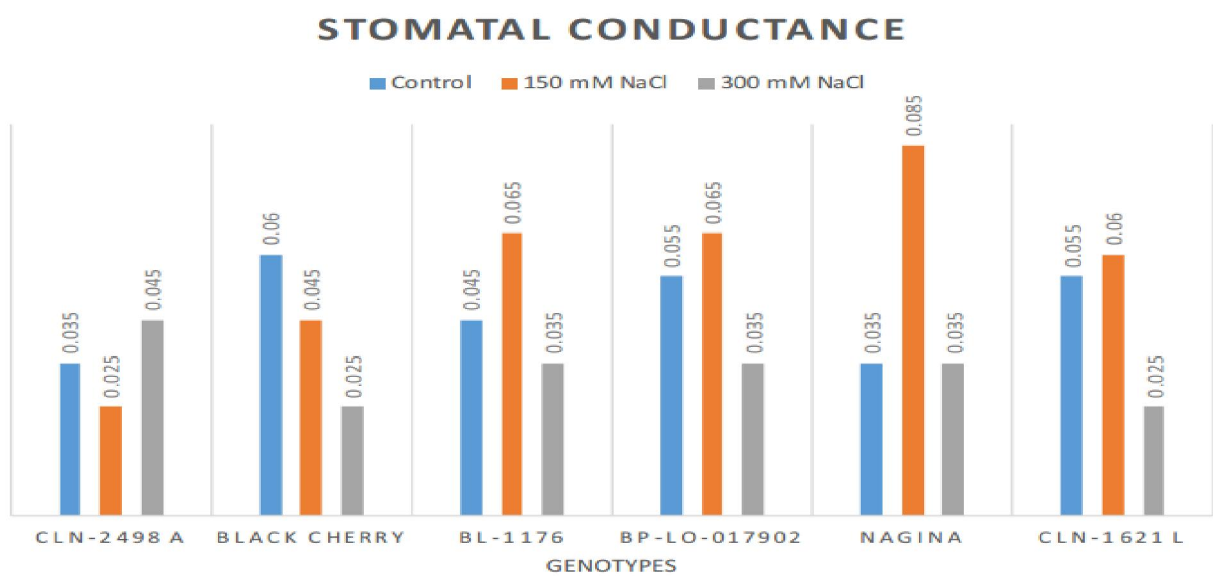

Figure 12: Effect of salinity level on stomatal conductance of various genotypes of Tomato. Bars represent standard error.

Transpiration rate:

Statistical analysis exhibited significant differences among treatment and genotypes regarding transpiration rate. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 15 revealed means performance of genotypes at salinity levels for transpiration rate. According to the means genotype Nagina with maximum mean value 2.7133 considered as the best and genotype Black cherry having a minimum value of 1.6633. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 13

indicated the interaction of the transpiration rate means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 13 genotype Nagina represented performed best and genotype Black cherry performed as poor under different salt stress levels.

Table 15: Effect of salinity level on transpiration rate (mmol m-2 sec-1) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means	
CLN-2498 A	2.3	1.27	2.08	1.8833	E
Black Cherry	1.92	2.18	0.89	1.6633	F
BL-1176	2.16	3.2	2.01	2.4567	C
BP-LO-017902	2.6	2.25	1.2	2.0167	D
Nagina	2.04	4.2	1.9	2.7133	A
CLN-1621 L	3.1	2.95	1.5	2.5167	B
Means	2.3533 B	2.675 A	1.5967 C		

Table 16: Effect of salinity level on CO2 gas exchange (mmol m-2 sec-1) of various genotypes of Tomato. Treatments

Genotypes	Control	150 mM NaCl	300 mM NaCl	Means
CLN-2498 A	231.5	248.5	126.5	202.17 F
Black Cherry	268.5	345.5	207.5	273.83 D
BL-1176	210.5	266.5	198.5	225.17 E
BP-LO-017902	314.5	398.5	254.5	322.5 B
Nagina	151.5	245.5	467	288 C
CLN-1621 L	384.5	592.5	392	456.33 A
Means	260.17 C	349.5 A	274.33 B	

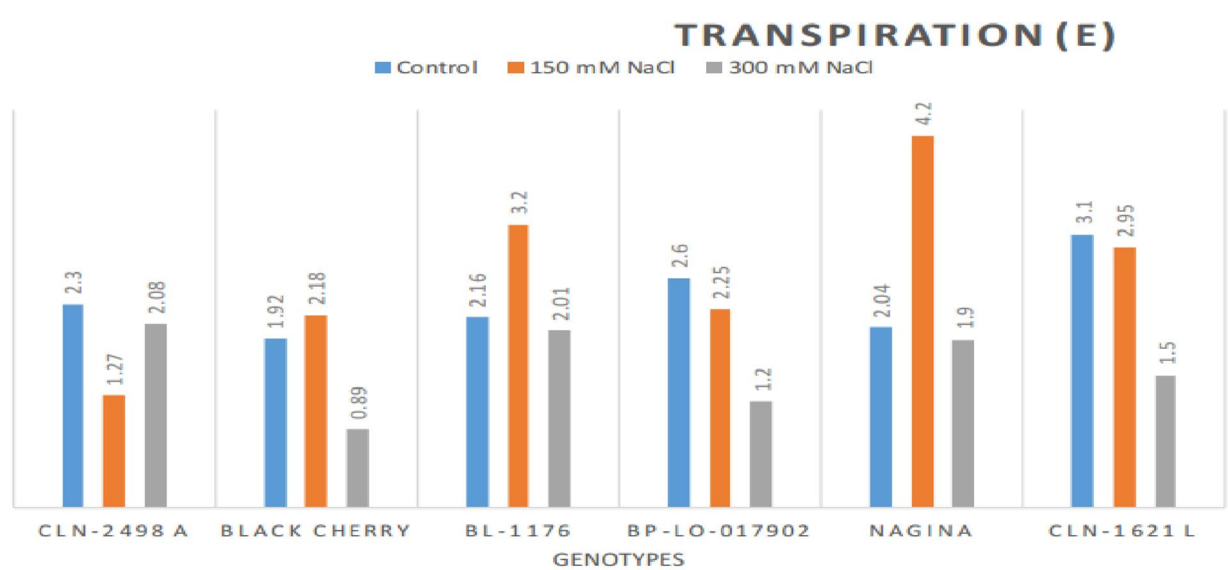

Figure 13: Effect of salinity level on transpiration rate of various genotypes of Tomato. Bars represent standard error.

CO2 gas exchange:

Statistical analysis exhibited significant differences among treatment and genotypes regarding CO 2 gas exchange. Which means that genotypes performed differently in the stress and normal conditions. There was non-significant relation for the interaction between genotypes and different salt stress levels. Which implies that at interaction that there was no variation existed. Table 16 revealed means performance of genotypes at salinity levels for CO_2 gas exchange. According to the means genotype CLN-1621-L with maximum mean value 455.67 considered as the best and genotype CLN-2498-A having a minimum value of 201.67. All six genotypes behaved in different manners. Overall results indicated that due to salinity level increased, plant decreased. Fig. 13 indicated the interaction of the CO_2 gas exchange means between genotypes and different salt stress levels. There was significant relationship among genotypes under different salt stress levels. As depicted form the Fig. 13 genotype CLN-1621-L represented performed best and genotype CLN-2498-A performed as poor under different salt stress levels.

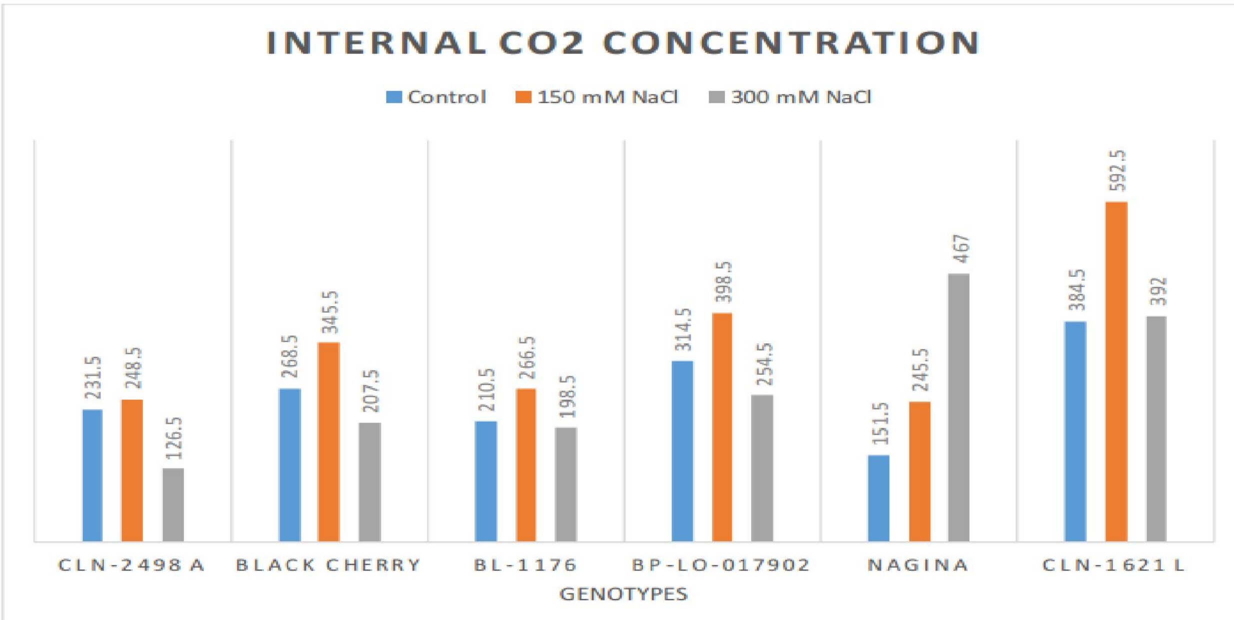

Figure 14: Effect of salinity level on CO2 gas exchange of various genotypes of Tomato. Bars represent standard error.

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