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Effects of Salinity on Growth of Tomato

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Abstract

This research work reports effects of salinity on external and internal morphology of tomato (*Lycopersicon esculentum.* M.) Plants under salt stress conditions showed inhibition in root, shoot and leaf growth. Fresh and dry weight of roots and shoot was also reduced in plants treated with higher concentrations of NaCl. Leaves also showed yellowing and stunted growth which was further evaluated by estimating the chlorophyll content which was significantly reduced under higher concentrations of NaCl. Enzymatic activity like acid phosphatase and peroxidases was also altered in plants treated with higher concentration of salt, suggesting the sensitivity of tomato plants against saline conditions.

Keywords: Chlorophyll content; Morphology; Peroxidase; Salinity; Tomato.

1. Introduction

Inhibition of plants growth due to salinity is reported in many plants which have developed different mechanisms to cope with these effects. In many plants, effects of salinity are more pronounced at higher concentrations [1,2,3] showing overall reduction in plants growth including root and shoot growth, leaf area [4], reduction in chlorophyll content, delayed flowering, and altered enzymatic activities [5, 6]. Along with chlorophyll 'a' and 'b', carotene and xanthophyll contents are also affected in many plants under saline conditions [7]. Salinity can also cause changes in anatomical characteristics of many plants leaves [8, 9]. Salt stress in many plants is also responsible for cellular accumulation of damaging active oxygen species which may further cause proteins, membrane lipids and nucleic acids [10,11]. Saline conditions also cause change in lipid metabolism and lipid peroxidation which can cause deterioration in membrane [12]. Accumulation of proline in response to salt accumulation is also reported in some plants [13,14]. Reduction in chlorophyll contents reduces the rate of photosynthesis in many plants as stomatal size and rate of transpiration is also affected under salt stress [15].

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2. Materials and Methods

2.1. Experimental setup /area of work

Three sets of plants were selected for each treatments. They were grown in pots in the botanical garden of Kinnaird College, Lahore. One set was was taken as control, second and remaining plants were treated with different concentration of NaCl i.e., 30 ppm, 50ppm and 80ppm.

2.2. Water Treatments

Each set was given 300 ml of water of each type. All plants were grown outdoors under natural day light in equal sized earthen pots. Plants selected were of almost same age. They were treated with different concentrations of NaCl for one month.

2.3. External and Internal Morphology

For external and internal morphology, length and diameter of root and shoot were calculated. Minitab V (13) Mean, standard error of the mean, one way ANOVA were calculated.

2.4. Estimation of Enzymatic Activities (Peroxidases)

In a cold pastle and mortar, weighed and frozen plant material was crushed with phosphate buffer (0.1M; pH 7) (Table 4.1.12) in the ratio of 1:4 (w/v) i.e., 1 gm of plant material; 4 ml of phosphate buffer. The samples were centrifuged at 10,000 rpm for 10 minutes. The supernatant was used for estimation of peroxidases. Two sets of test tubes were labeled (one for experimental and one for control). In all the test tubes (2 sets) 2.5 ml of phosphate buffer (pH 7.0) 0.2 ml of enzyme extract was added. In experimental set 0.2 ml of 1% Guaiacol solution was added and mixed. Both the sets were left at room temperature for 15-20 minutes. Then 0.1 ml of 0.3% H_2O_2 was added in all the test tubes and stirred. For blank, 0.2 ml of glass distilled water, 2.5 ml of phosphate buffer (pH 7.0) and 0.1 ml of 0.3% of H_2O_2 was mixed. Optical density of all the test tubes was taken against this test tube for blank. The absorbance was taken at 750 nm on a Beckmann 200D spectrophotometer.

Formula used for peroxidases were as follows:

$$\text{Units mg-1} = \frac{\text{O.D of experimental} - \text{O.D. of control}}{\text{O.D of control x mg of fresh plant material}}$$

3. Results

In current work, 30-ppm and 50 ppm-treated plants showed slight decrease in length of whole plants when compared with untreated control plants. However, dose of 80 ppm NaCl showed 50% decrease in relation to control plants as shown in table 1. Similarly length of root was also reduced in all treated plants and dose of 80 ppm- treated plants showed 60% decrease (table 1, fig. 1-3). Similarly number of rootlets were also reduced with all doses of NaCl. Furthermore, shoot of all plants also showed decrease in length and diameter (table 1). Increase in peroxidase activities was also reported in all treatments of NaCl (table 2).

Table 1: Effects of different doses of NaCl on external morphology of *L. esculentum* after 4 weeks (readings are the mean of five replicates)

Treatments (ppm)	**Length of whole plant (cm)**	**Length of root (cm)**	**Width of shoot (cm)**	**Number of root leaflets**
Control	23.50 ± 0.67	11.00±0.54	0.27±0.12	36.12±0.80
30 NaCl	22.47 ± 0.13	11.41±0.02	0.24±0.76	22.23±0.76
50 NaCl	15.76 ± 0.65	5.67±0.86	0.18±0.28	30.10±0.55
80 NaCl	13.37 ± 0.02	4.33±0.10	0.14±0.86	24.45±0.44

Table 2: effects of different doses of NaCl on peroxidase activity of *L. esculentum* after 4 weeks (readings are the mean of five replicates)

PART (MG-1)	**TREATMENTS**			
	CONTROL	**30 PPM**	**50PPM**	**80PPM**
ROOT (mg-1)	2.89±1.091	3.15± 0.890	3.03±0.667	3.90±.0.4559
1^{ST} INTERNODE (mg-1)	2.93±1.267	2.76±0.198	2.18±0.278	2.98±0.0560
1^{ST} LEAF (mg-1)	2.05±0.0.43	3.10±0.003	3.45±0.459	3.36±0.0320

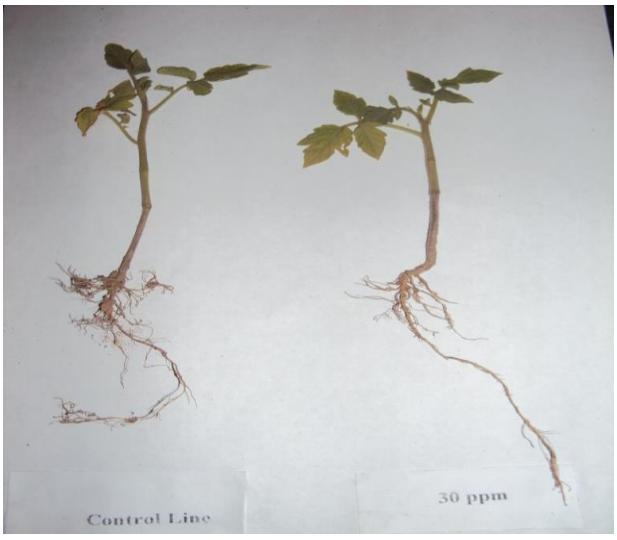

Figure 1: Effects of 30 ppm treatment on length of *L. esculentum*

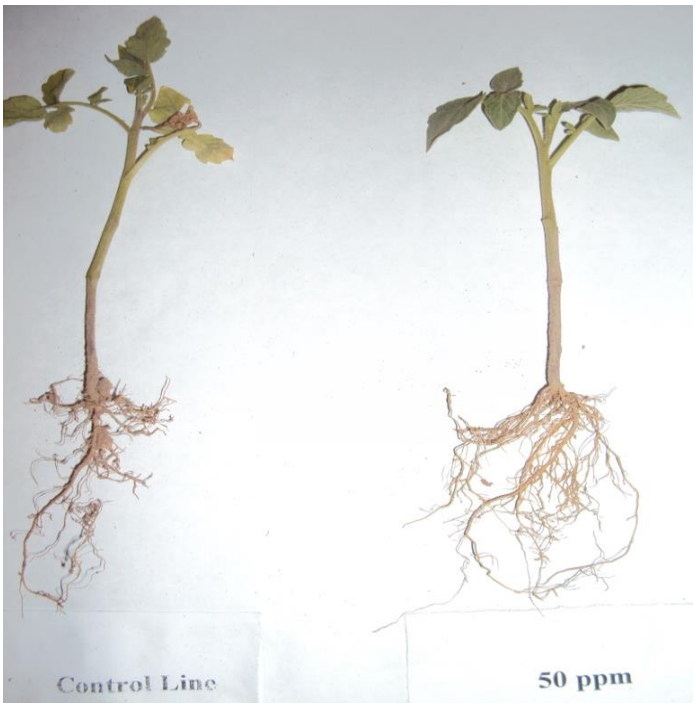

Figure 2: Effects of 50ppm treatments on length of *L. esculentum*

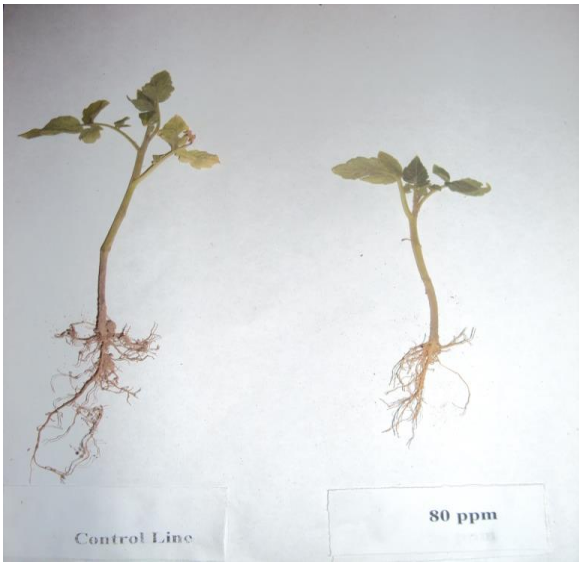

Figure 3: Effects of 80ppm treatments on length of *L. esculentum*

4. Discussion

Growth is chiefly expressed as a function of genotype and environment, which consists of external growth factors and internal growth factors. Plants in the environment are exposed to a range of abiotic stresses like osmotic, salinity, temperature and heavy metal toxicity, which affect their growth and other physiological processes [16]. Root morphology can directly affect the uptake of water, minerals and heavy metals [17]. The productivity of plants is greatly affected by various environmental stresses. Soil salinity affects plant growth and development by way of osmotic stress, injurious effects of toxic Na+ and Cl– ions. Salinity stress response is

multigenic, as a number of processes involved in the tolerance mechanism are affected, such as various compatible solutes/osmolytes, polyamines, reactive oxygen species and antioxidant defense mechanism, ion transport and compartmentalization of injurious ions. In the current work, length of tomato root and shoot showed reduction in all the treated plants with all doses of NaCl (fig-1-4). This inhibition may be attributed to inhibition of cell division in apical meristems, which disrupted the metabolic pathway responsible for elongation growth. Salt stress in the soil generally involves osmotic stress and ion injury, alkali stress exerts the same stress factors but with the added influence of high-pH stress. The high-pH environment surrounding the roots can directly cause Ca^{2+}, Mg^{2+} and $H_2PO^{4\ -}$ to precipitate and may inhibit ion uptake [18] and disrupt the ion homeostasis of plant cells. The deleterious effects of salt stress are commonly thought to result from low water potentials and ion toxicities. In the current work inhibition in length of root can be attributed due to above mentioned reasons. The role of peroxidase as a stress enzyme in plants has been widely accepted [19]. In all the treated plants, increase in enzyme activity was observed (table 2), further indicating the role of radiations in inducing stress in different parts of plants. Maximum enzyme activity was detected in roots, then in shoot and in leaves. This might be due to different level of tolerance to stress of different plants [20]. Roots of plants were more responsive to stress because peroxidase activity was maximum in the roots of treated plants, showing the sensitivity of roots to radiations.

5. Conclusions

The inhibitory effects of salinity were reported in all the treated plants. It was observed that growth of tomato plants was reduced with all doses of NaCl, however, dose of 80ppm registered significant inhibitory effect as compared with lower doses, concluding that higher salt concentrations are more lethal for tomato plants.

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