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Effect of exogenous application of salicylic acid on some morphological parameters in salt stressed tomato varieties

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ABSTRACT : Salt stress is a major environmental constraint limiting plant productivity. Tomato (*Lycopersicum esculentum*) is one of the commodity vegetable that has recently been added to the list of the world's major food crops and is considered as one of the most popular vegetable. An experiment was conducted to study the effect of salicylic acid (SA) on tomato varieties grown in different levels of salt stress. Salicylic acid (SA) is a plant growth promoting compound relatively inexpensive and enhances growth and yield of crops under saline conditions. The effect of exogenous salicylic acid (25µM) application of with four NaCl concentrations (50mM,100mM, 150mM and 200mM) stressed tomato varieties was investigated. Results on some morphological parameters as plant-height and number of leaves revealed that, salt stressreduced plant-height and number of leaves. While, exogenous application of salicylic acid promoted plant-height and number of leaves and counteracted the salt stress-induced inhibition of plant-height and number of leaves.

KEY **W**ORDS : Salt-stress, Tomato, Salicylic acid, Plant-height

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Salinity is amongst the major environmental determinant for plant growth and productivity (Delavari *et al.,* 2010). Exposure of plants to NaCl reduce the availability of water for the plants, thus causes osmotic stress. The dominance of Na+ and Cl- ions inhibit the uptake of other minerals vital for plant's growth (Ghanem *et al*., 2008; Albacete *et al*., 2008 and Hamdia and Shaddad, 2010).Netphotosynthesis, transpiration rate and stomatal conductance are significantly affected by salt stress due to changes inchlorophyll content and chlorophyll fluorescence, damage of photosynthetic apparatus and chloroplast structure(Abd *et al.,* 2000 and Fidalgo *et al*., 2004). Tomato is one among the most important horticultural crops in the world and tomato plant growth was shown to be moderately sensitive or moderately tolerant to salinity depending on cultivar or growth stage (Santa-Cruz *et al.,* 2002; Fernandez-Garcia *et al*., 2004 and Estan *et al*., 2005).

Salicylic acid can enhance the plant growth, yield and quality (Khodary, 2004). Salicylic acid might alleviate the imposed salt stress, either via osmotic adjustment or by conferring desiccation resistance to plant cells (Khodary, 2004 and Gunes *et al.,* 2007). Salicylic acid is naturally present in plants and it plays an important role

in growth and stress tolerance (Noreen *et al*., 2009; Khan *et al*., 2010 and Purcarea and Cachiþã-Cosma, 2010) in addition to participation of the internal signals regulating the defensive response of plants against pests, pathogens (Girling *et al*., 2008 and Zhang *et al*., 2009) and abiotic factors (Khan *et al*., 2010 and Ogawa *et al*., 2010). Application of salicylic acid affected tomato yield and quality characters of tomato fruits (Javaheri *et al.,* 2012). The aim of present work was to study the effect of exogenous application of salicylic acid on plant-height and number of leaves in different tomato varieties grown under different levels of salt stress.

RESEARCH PROCEDURE

Tomato seeds of twenty varieties were obtained from the Indian Institute of Vegetable Research, Varanasi. Seeds were allowed to germinate in three replicates according to trial pots in Complete Randomized Design.

The plants growth parameters including plant height and number of leaves were examined for morphological analysis in tomato varieties grown under following growth conditions (treatments):1) Control (only tap water), 2) 25µM SA, 3) NaCl 50 mM, 4) NaCl 100 mM, 5) NaCl 150 mM, 6) NaCl 200mM, 7) NaCl 50 mM+ 25µM SA, 8) NaCl 100 mM + 25µM SA, 9)NaCl 150 mM + 25µM SA, 10) NaCl 200 mM + 25µM SA.

Ten seeds of each tomato variety were sown duringmid-August during season 2014 directly in plastic pots (20 x 25 cm) containing 3.0 kg of peat, clay and sand mixture in equalratios and kept inside polyhouse under natural light. Soil was allowed to equilibrate in the greenhouse for 1 week before seed sowing. After germination, plants were thinned to one plant per pot. At the first until 20 days from sowing irrigation with tap water was applied twice a week and the pots were irrigated every 2 weeks.

NaCl treatments :

Twenty days after sowing tomato plants were subjected to 0 mM (control), 50 mM, 100 mM, 150mM and 200mM NaCl concentrations using 0.5L irrigation water per pot.

Salicylic acid (SA) application :

Salicylic acid (SA) was procured from sigma Aldrich Chemicals Pvt. Ltd., India. A solution of SA (25µM) was prepared by dissolving required quantity of SA in 5ml of ethanol in a 100 ml volumetric flasks and the final volume was made upto the marked by using DDW. Tween-20 was added prior to the treatment.The foliage of each plant was sprinkled thrice. The nozzle of the sprayer was adjusted in such a way that it pumped out 1 ml (approx) in one sprinkle. Therefore, each foliage of plants finally received 3 ml salicylic acid solution.

Morphological traits :

Plant height was measured by using a meter scale (from ground level to the topmost part of the plants) and numbers of leaves counted per plants after 10 days of treatments for getting the morphological data. These observations recorded in 3 replicates.

RESEARCH ANALYSIS AND REASONING

The effect of salicylic acid alone and in combination with different concentration of NaCl was studied on plant-height and number of leaves in different tomato varieties. The result showed that application of salicylic acid alone showed a positive response on plant-height as well as on number of leaves in different tomato varieties. Result also showed that there was a dramatic decrease in both the characters *i.e*. plant-height and number of leaves with the increasing concentrations of NaCl. Application of 25µM salicylic acid exhibited positive response on both of the characters in different levels of salt stress in tomato varieties. Therefore, in general salicylic acid was notified to overcome the adverse effect imposed by salt stress. Effect of salicylic acid alone, 100mM NaCl, 150mMNaCl, 200mM NaCl and 50mMNaCl+ 25µM salicylic acid on plant-height of different varieties of tomato was found to be non-significant. Whereas effect of 50mM NaCl concentration, 100mM + 25µM salicylic acid, 150mM salt+ NaCl and 200mM salt + 25µM salicylic acid showed as significant variations in plant-height of different tomato varieties (Table 1).

The result showed that among all the tomato varieties, variety H-8871-1 showed the maximum plant-height with the application of salicylic acid alone (*i.e.* 10.7 cm) and this variety also responded the maximum plant-height with 50mM + 25µM salicylic acid. Whereas the variety H-24 showed that the minimum plant-height (*i.e.* 2.3 cm) by the application of salicylic acid alone and this variety also exhibited the minimum plant-height in 50 mM NaCl +25µM SA and 200mM NaCl +25µM SA as well. In general salicylic acid was noticed to overcome

the adverse effect imposed by NaCl.

The exogenous application of salicylic acid showed a significant increase in number of leaves either under different levels of salt stress or alone (Table 2).The results showed that among all the tomato varieties, variety T-Loeal and WIR-3928 the maximum number of leaves with the application of salicylic acid alone (*i.e.*11.30) whereas variety Arka Marginal andVRT-2 showed the minimum number of leaves (6) in control condition and variety H-24 showed the minimum number of leaves with the application of salicylic acid.

The results of showed that (Table 2) salicylic acid affected the number of leaves significantly. Number of leaves were reduced by increase in salt stress levels significantly (Table 2). The exogenous application of salicylic acid showed a significant increase in number of leaves either under different levels of salt stress or alone (Table 2). Number of leaves showed a significant variation

Table 1: Effect of salicylic acid (25µM), different levels of NaCl (50mM, 100mM, 150mM and 200mM) and different levels of NaCl and SA on plant-height (cm) in different tomato varieties

Variety	Plant-height (cm)									
	control	SA (25µM)	50mM (salt)	100mM (salt)	150mM (salt)	200mM (salt)	50mM (salt)+ SA(25µM)	100mM (salt)+ SA(25µM)	150mM (salt)+ SA(25µM)	200mM (salt)+ SA(25µM)
H-8878-1	9.90	10.70	9.00	6.90	4.40	2.80	10.40	7.40	5.00	3.50
WIR-13706	6.00	6.70	5.10	4.50	3.80	2.60	6.20	5.10	4.40	3.00
Anigoarlentha	4.70	5.10	3.90	3.50	2.80	1.80	4.80	4.20	3.30	2.40
Ec-521080	5.50	6.50	4.80	4.30	3.70	2.80	5.80	4.90	4.30	3.60
Arka marginal	6.30	7.00	5.20	4.50	3.80	2.30	6.40	5.20	4.40	2.80
Ec-520079	4.80	5.30	3.70	3.30	2.80	1.90	4.90	4.20	3.50	2.30
WIR-3957	2.80	3.40	2.30	2.00	1.70	1.30	3.00	2.60	2.10	1.90
P-6 chhuchara	4.60	5.40	3.90	3.50	3.10	2.50	5.00	4.20	3.80	3.00
VRT-2	2.10	2.60	1.70	1.40	1.20	1.00	2.20	2.30	1.80	1.70
H-24	1.60	2.30	1.40	1.20	1.20	1.10	1.70	1.80	1.80	1.70
Roma	1.80	2.80	1.50	1.30	1.10	1.10	2.20	1.80	1.90	1.50
Ec-520078	2.60	3.60	2.20	1.80	1.50	1.10	2.80	2.60	2.40	1.60
T-Loeal	3.50	4.70	3.00	2.60	2.10	1.70	3.70	3.30	3.10	2.30
ArkaSaurabh	3.90	4.50	3.30	2.80	2.30	1.70	3.80	3.30	2.80	1.90
H-86	4.60	5.00	4.10	3.50	2.90	1.80	4.60	4.20	3.50	2.20
Ec-520061	2.80	3.70	1.80	1.50	1.30	1.00	3.00	2.40	1.70	1.60
DT-10	5.00	5.40	4.20	3.60	3.00	2.00	5.10	4.30	3.50	2.40
Agata-30	6.70	7.40	5.90	5.20	4.60	3.20	6.60	5.80	5.10	3.60
WIR-13708	7.40	8.00	6.50	5.60	5.10	3.80	7.50	6.50	5.70	4.50
WIR-3928	6.80	7.80	6.10	5.40	4.90	3.50	6.80	6.10	5.60	3.80
S.E.±	1.40	1.47	1.41	1.26	1.13	0.95	1.50	1.32	0.95	1.00
C.D. (P=0.05)	2.82	2.97	2.86	2.54	2.29	1.92	3.05	2.67	1.92	2.03
C.V.	23.73	18.19	26.57	26.38	27.83	28.31	21.89	22.43	18.80	22.91
F- test	S	NS	S	NS	NS	NS	NS	S	S	S

Number of leaves showed a significant variation in different varieties in all the treatments NS= Non-significant

in different varieties in all the treatments.

The effect of salicylic acid on number of leaves of different varieties of tomato was significant either in alone or in combinmation with different levels of salt stress.

Salinity induced growth reduction has been well documented in several plant species by Eraslan *et al*. (2007a) on lettuce, Maggio *et al*. (2007) on tomato (Eraslan *et al*., 2007b) on carrot and Delavari *et al*. (2010) on *Ocimum basilicucm*. Plants treated with salicylic acid grown under salinity conditions enhanced all growth parameters and yield compared with salinity treatment only. This positive effect of salicylic acid may be attributed to the increase of CO_2 assimilation and photosynthetic rate and increased mineral uptake in stressed plant under SA application (Szepesi *et al*., 2005). Salicylic acid significantly increased plant growth either under stress or without stress conditions. This effect probably related to salicylic acid inhibition of Cl^- and Na+ absorption and its help for Mg, Fe, Mn, N and Cu absorption or results from its effect on

Table 2 : Effect of salicylic acid (25µM), different levels of NaCl (50mM, 100mM, 150mM and 200mM) and different levels of NaCl and SA on number of leaves in different tomato varieties

Variety	Number of leaves									
	Control	SA (25µM)	50mM (salt)	100mM (salt)	150mM (salt)	200mM (salt)	50mM (salt)+ SA(25µM)	100mM (salt)+ SA(25µM)	150mM (salt)+ SA(25µM)	200mM (salt)+ SA(25µM)
H-8878-1	7.00	9.00	6.00	5.6	4.6	4.00	8.60	7.00	5.30	5.00
WIR-13706	8.00	10.60	7.00	5.60	4.30	3.60	9.00	7.00	6.00	4.60
Anigoarlenha	8.30	10.60	7.30	7.00	5.60	5.00	9.30	8.00	6.30	5.60
Ec-521080	8.60	10.60	7.60	7.30	6.00	5.30	9.60	8.30	7.30	6.00
Arka marginal	6.00	9.30	6.30	5.00	4.60	4.00	8.00	6.30	6.00	5.00
Ec-520079	7.00	9.30	6.30	5.60	5.00	4.60	8.60	6.60	6.00	5.00
WIR-3957	8.30	10.30	7.30	6.60	6.00	5.30	8.30	7.60	7.00	7.00
P-6 chhuchara	7.60	9.30	7.60	6.30	5.30	4.60	9.00	7.60	6.60	5.60
VRT-2	6.00	8.30	5.3	4.60	4.00	3.30	7.30	6.00	5.60	6.00
H-24	6.30	8.00	6.30	5.30	4.30	3.30	7.60	7.60	5.00	5.00
Roma	6.60	9.00	5.60	5.00	4.00	3.60	7.60	6.30	5.60	5.00
Ec-520078	7.00	11.00	6.30	5.60	5.00	4.00	8.30	7.60	7.00	5.30
T-Loeal	7.30	11.30	6.60	6.30	6.00	4.00	8.00	8.00	6.60	5.60
ArkaSaurabh	6.60	10.60	6.30	5.60	5.00	4.00	8.00	7.00	5.60	6.00
H-86	7.60	9.60	7.00	6.00	5.60	4.00	9.00	7.00	6.00	5.60
Ec-520061	7.00	9.00	6.00	5.60	5.30	4.30	8.00	7.00	7.00	4.60
DT-10	7.00	11.00	7.00	6.00	4.60	3.60	8.60	7.60	6.60	4.60
Agata-30	6.30	9.00	5.60	5.00	4.00	3.60	7.60	6.30	5.60	5.00
WIR-13708	7.00	9.60	6.30	6.00	5.00	3.30	7.60	7.60	6.00	4.60
WIR-3928	8.00	11.30	7.00	6.00	5.00	4.00	9.60	8.00	5.60	5.60
S.E.±	1.38	1.90	0.95	0.89	0.81	0.70	0.89	0.92	0.81	0.77
C.D. (P=0.05)	2.80	3.85	1.93	1.80	1.64	1.41	1.81	1.87	1.64	1.56
C.V.	36.06	42.97	29.14	31.50	34.31	41.23	22.53	27.25	28.20	36.50
F- test	S	S	S	S	S	S	S	S	S	S

lipid per oxidation and membrane permeability. In cucumber and tomato, the fruit yield was enhanced significantly when the plants were sprayed with lower concentrations of salicylic acid (Larque-Saavedra and Martin-Mex, 2007).

Increasing of pepper (Hayat *et al.*, 2010), tomato and cucumber fruit number (Elvwan and Hamahyomy, 2009) were observed due to foliar spray of salicylic acid in low concentration.

Tomato treated with salicylic acid had higher fruit yield compared to non-treated plants due to an increase in number of cluster per plant (Javaheri *et al.*, 2012).

Conclusion :

In conclusion, exogenous salicylic acid treatments did not completely recover the deleterious effects of salt stress on the growth of tomato plants, but especially the 25µM salicylic acid concentration improved plant tolerance to salinity as compared to the non-stressed plants. Salicylic acid treatments was found to ameliorate the negative effect of salinity on the growth of tomato plants growing under different levels of salt stress conditions.

Foliar application of salicylic acid (SA) with 25µM concentration could enhance quantity and quality of tomato fruits. The addition of salicylic acid could offer an economical and simple application to the salt sensitive plant of tomato production problems caused by high salinity but further studies are required in order to determine the efficiency of these materials under natural field condition.

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