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RESPONSE OF TOMATO (*Lycopersicon esculentum* Mill.) CULTIVARS TO DIFFERNT LEVELS OF SALINE IRRIGATION WATER

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ABSTRACT : The present study aspired to evaluate some tomato cultivars under different levels of saline irrigation water under poly house. Six widely cultivated varieties *viz.,* Gujarat Tomato^{-1}, Junagadh Tomato-3, Coimbatore-3, Arka Vikas, Pusa Ruby and Pusa Early Dwarf were evaluated. The study outcome expressed a relation that consistent decrease in growth with increase salt concentration in saline irrigation water. About fifty per cent decrease in growth, flower and yield parameters was observed at 5.0 dSm^{-1} level of saline irrigation water. The quality of fruits (TSS, Ascorbic acid, Acidity, Reducing sugar, Total sugar and Proline) was increased with increasing salt concentration in saline irrigation water. Pusa Ruby and Junagadh Tomato-3 gave better response with increased salt levels in irrigation water. The variety Pusa Ruby gave maximum plant height (155.25 cm) and number of branches (30.92) per plant and variety Junagadh Tomato-3 gave highest yield and quality parameters with different levels of saline irrigation water.

Key words : *Saline irrigation, tomato varieties, growth, yield.*

Tomato (*Lycopersicon esculentum* Mill.) is a solanaceous fruit and one of the most popular vegetables grown all over the world. Tomato is the world's third largest crop after potato and sweet potato, but it tops the list of canned vegetables. It is cultivated as a cash crop as well as a vegetable crop on commercial lines in almost all parts of India. Its fruits are abundantly rich in vitamins, mineral, and organic acids, and also contain various flavouring compounds, which enrich the taste and flavor of all vegetable dishes prepared from it. It is also one of the most important raw materials for processing industry for making several processed products. In arid and semi-arid regions the problem of soil salinity and sodicity in ground water and irrigated soil is very common. Enough to interfere with the normal growth of several crop plants are called saline. These have electrical conductivity of the saturation extract more than 4.0 dSm^{-1} at 25°C, pH less than 8.5 and exchangeable sodium percentage (ESP) less than 15 (Mangal and Singh, 10). It is estimated that in India, about 8.0 million hectare of salt affected soils at different stages of degradation (Mangal *et al.,* 11), the extent of salinity is estimated as 11.04% in Gujarat state. Salt tolerance of plants is not only varies considerably among species but also depends upon the cultural conditions under which the crop is grown. There are several factors, such as soil, water, plant and environment which affect the salt tolerance of a plant. The degree to which growth and normal metabolism can be maintained in such saline condition is described as salt tolerance (Mangal *et al.,*12). Therefore, plants response to the given salt concentration is not to be predicted on an absolute basis. However, plants can be compared on a relative basis. Plants tolerance to salinity is usually appraised, in one of the three ways: (i) The ability of plant to survive in saline conditions (ii) The absolute plant growth and yield and (iii) The relative growth or yield on saline as compared to non-saline soil (Magar *et al.,* 8). Hence, evaluating these tomato varieties with different levels of salt concentration in irrigation water under polyhouse may give sense to choose better cultivar to cultivate under irrigation water affected with salt.

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MATERIALS AND METHODS

The present experiment was carried out under polyhouse at Hi-Tech Horticulture Park, Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, during the *Kharif* 2010. The treatments include two factors viz., Factor A (Varieties) comprise V_1 = Gujarat Tomato – 1 (GT – 1), V_2 = Junagadh Tomato – 3 (JT – 3), V_3 = Coimbatore – 3 (Co – 3), V_4 = Arka Vikas, V_5 = Pusa Ruby and V_6 = Pusa Early Dwarf and Factor B (Saline water levels) comprise S_1 = Well water (0.9 -1.2 EC dSm^{-1}), S_2 = 3.0 EC dS m^{-1}, S_3 = 5.0 EC dS^{-1}, S_4 = 7.0 EC dSm^{-1} and S_5 = 9.0 EC dS m^{-1}. The experiment was laid out

with factorial concept in Completely Randomized Design (FCRD) with 30 treatment combinations arising from six tomato cultivars and five levels of saline irrigation water with three replications. The desired salinity levels in water attained by dilution of sea water in measured quantity of water (*i.e.* on the basis of measured EC of tap water). The earthen pots (37 × 30 cm) were used for growing of tomato plants. A pair of six pots was considered as one replication for each treatment combination. The seedlings of six varieties of tomato were raised in earthen pots. In each pot, two healthy seedlings of tomato for each variety were transplanted. After establishment of seedlings pots were irrigated with equal quantities of different levels of saline water, whereas control was irrigated with well water. The plants were protected from the attack of insect pests, and disease by adopting appropriate control measures. Five plants were selected randomly and tagged properly to record the observations. The various traits studied for growth parameters are survival percent (%) of plant, plant height at 40, 80 DATP and final harvest (cm), and number of branches per plant at 40, 80 DATP and final harvest. The flowering parameters are days to first flower appearance, days to fruit setting, days to first harvesting and productive span (days) while the yield parameters are number of fruits per plant, weight of fruits per plant (kg), average weight of single fruit (g) and fruit diameter (cm) likewise quality parameters i.e. total soluble solids (%), ascorbic acid (mg/100g of pulp), acidity (%), total sugar (%), reducing sugar (%) and proline (%) also were recorded. The statistical analysis was carried out as per the methods suggested by Panse and Sukhatme (13) for Factorial Completely Randomized Design.

RESULTS AND DISCUSSION

The findings indicated that irrespective of saline conditions all the varieties differed significantly to each other in plant height. At final harvest of tomato maximum plant height (155.25 cm) was observed in Pusa Ruby (V_5) and minimum (138.09 cm) was in Coimbatore-3 (V_3). Similar results were also observed by Maliwal (9) in tomato. Irrespective of the variety, the effect of saline irrigation water on plant height (cm) at final harvest of tomato was significant, and plant height gradually decreased as concentrations of saline irrigation water was increased (Table 1). The decrease in plant height was more pronounced above 5.0 dSm^{-1} level of saline irrigation water. In general, the maximum plant height (170.97cm) was noted in control (1.2 dSm^{-1}) and the lowest was at 9.0 dSm^{-1} EC of irrigation water. Plant height of tomato was found to be decreased with increase in salt concentration was reported by Kazim (7). Results presented in Table 1 showed that significant differences among varieties of tomato were observed on number of branches per plant. In general, variety Pusa Ruby (V_5) gave the highest number of branches (30.92) per plant. These findings are in conformity with the results of Taffouo *et al.* (16) and Turhan *et al.* (17) in tomato. Gradually significant decreases in number of branches per plant due to increase in salinity levels was observed. The highest number of branches per plant (34.03) was in control, while the lowest (26.54) was at the highest salinity (9.0 dSm^{-1}). These findings are also supported by Turhan *et al.* (17)

The minimum days to first flower appearance (37.84 days) was recorded with Pusa Ruby (V_5) as in fruit set and first harvest the minimum days (59.77 days and 99.58 days respectively) were recorded with Junagadh Tomato-3 (V_2), this might be due to the variation existed in genetic makeup of different varieties. These findings are in conformity with the results of Taffouo *et al.* (16) in tomato. Increased levels of saline irrigation water resulted in delayed for days to first harvest. The maximum days to first harvest (102.82 days) was recorded in S_5 (9.0 dSm^{-1}), while it was minimum (97.98 days) in control. Present study revealed that salinity prolonged the days to flowering, which results in delayed fruit set and first harvest. These results are accordance with the findings of Douglas and Ausra (2) in tomato. A perusal of data in Table 1 revealed that the varietal response was significant for productive span of tomato. It is clear that maximum productive span (16.51 days) was observed in Junagadh Tomato-3 (V_2), while it was minimum (14.35 days) in Pusa Early Dwarf (V_6). The productive span of tomato was adversely affected by saline irrigation water (Table 1). Productive span of tomato was gradually decreased as concentrations of saline irrigation water increased. Highest days of productive span (21.51) were observed in control, while it was lowest (10.04) at highest salt concentration (9.0 dSm^{-1}) of irrigation water. These findings are in conformity with the results of Shamas *et al.* (15) in tomato. The interaction effect of variety and saline irrigation was also significant for productive span of tomato (Table 1). The highest productive span was with Junagadh Tomato-3 (V_2) in control (1.2 dSm^{-1}). The maximum number of fruits per plant (18.11) was observed in Junagadh Tomato-3 (V_2), while it was minimum (14.41) in Coimbatore-3 (V_3). These findings are in conformity with the results of Jaiswal (4) in tomato. The highest number of fruits per plant (22.59)

Table 1 : Effect of different levels of saline irrigation water on growth and flowering

Treatment	Plant height (cm)	No. of branches/ plant	Days to first flower	Days to fruit set	Days to first harvest	Productive span (days)
Varieties						
V_1 = Gujarat Tomato-1	144.57	30.31	39.25	62.31	100.59	15.70
V_2 = Junagadh Tomato-3	138.33	30.07	38.90	59.77	99.58	16.51
V_3 = Coimbatore-3	138.09	28.49	40.61	62.35	101.64	14.60
V_4 = Arka Vikas	143.57	29.01	37.95	63.09	101.10	14.64
V_5 = Pusa Ruby	155.25	30.92	37.84	62.04	101.67	15.12
V_6 = Pusa Early Dwarf	144.87	30.85	38.51	62.63	101.39	14.35
C.D. (P = 0.05)	9.81	1.65	1.87	2.13	1.42	0.59
Salinity						
S_1 = 1.2 EC dSm^{-1}	170.97	34.03	38.90	61.59	97.98	21.51
S_2 = 3.0 EC dSm^{-1}	162.87	30.92	38.26	62.02	100.66	16.19
S_3 = 5.0 EC dSm^{-1}	143.20	29.12	38.92	62.06	101.30	15.09
S_4 = 7.0 EC dSm^{-1}	131.44	29.11	39.03	62.16	102.20	12.93
S_5 = 9.0 EC dSm^{-1}	112.08	26.54	39.12	62.33	102.82	10.04
C.D. (P = 0.05)	8.95	1.51	NS	NS	1.30	0.54
Interaction (V x S)						
C.D. (P = 0.05)	NS	NS	NS	NS	NS	1.32
C.V. %	9.32	7.56	6.59	4.69	1.92	5.32

was observed in control, while the lowest number of fruits per plant was with S_5 (9.0 dSm^{-1}) level of saline irrigation water. This may be due to the pronounced flower drop, poor fruit set and higher fruit drop under saline condition. Similar results were also reported by Amor *et al.* (1) in tomato. Variety Junagadh Tomato-3 (V_2) gave highest number of fruits (25.20) per plant with control (1.2 dSm^{-1}). The maximum weight of fruits per plant (0.402 kg/plant) was observed in Junagadh Tomato-3 (V_2), but it was found at par with Gujarat Tomato-1 (V_1). Gradually, significant decrease in weight of fruits per plant was observed with increased level of saline irrigation water (Table 2). The variety Junagadh Tomato-3 (V_2) and Gujarat Tomato-1 (V_1) gave higher weight of fruits per plant with control as compared to other salinity levels. The average weight of single fruits was adversely affected by saline irrigation water. Maximum weight of single fruit (21.78 g) was observed in Junagadh Tomato-3 (V_2). The maximum weight of single fruit (24.449 g) was observed in control, while the minimum weight of single fruit (14.91 g) was with S_5 (9.0 dSm^{-1}) level of saline irrigation water. The highest weight of single fruit (21.58 g) was observed in Gujarat Tomato-1 (V_1) and it was found at par with Junagadh Tomato-3 (V_2) at control treatment.

Table 2 showed that the variety Junagadh Tomato-3 (V_2) gave highest TSS per cent (4.88%) while lowest (4. 50%) was with variety Pusa Ruby (V_5) followed by (4.53%) Coimbatore-3 (V_3). Increasing in levels of saline irrigation water had increased the TSS per cent of tomato fruit. The highest TSS per cent (5.57) was noted at highest salt concentration (9.0 dSm^{-1}) followed by 7.0 dSm^{-1}. Similar results were also observed by Kadam and Patel (6) in tomato. Significantly maximum acidity (0.73 %) in fruits was recorded by Junagadh Tomato-3 (V_2). The maximum acidity per cent (0.78) was observed in 9.0 dSm^{-1}, EC of irrigation water, while the minimum (0.53) was with 1.2 dSm^{-1} (control) level of saline irrigation water. The variety Junagadh Tomato-3 (V_2), gave highest acidity per cent at highest (9.0 dSm^{-1}) salinity, while variety Gujarat Tomato-1 (V_1) gave lowest acidity per cent with normal (1.2 dSm^{-1}) salinity. The maximum ascorbic acid (34.63 mg) was observed in Gujarat Tomato-1 (V_1) and it was at par with Junagadh Tomato-3 (V_2) and Arka Vikas (V_4), while it was minimum (33.01 mg) in Pusa Ruby (V_5). The highest ascorbic acid (40.23 mg) was noted at highest (9.0 dSm^{-1}) salt concentration followed by 7.0 dSm^{-1}. A role for increased ascorbic acid content in amelioration of oxidative stress has also been reported by Sairam *et al.* (14).

Table 2 : Effect of different levels of saline irrigation water on yield and quality.

Treatment	Fruits / plant	Fruit wt. (g)	TSS (%)	Acidity (%)	Ascorbic acid (mg/100g pulp)	Proline (mg %)
Varieties						
V_1 = Gujarat Tomato-1	16.49	21.58	4.75	0.65	34.63	0.247
V_2 = Junagadh Tomato-3	18.11	21.78	4.88	0.73	34.47	0.237
V_3 = Coimbatore-3	14.41	17.28	4.53	0.64	33.32	0.253
V_4 = Arka Vikas	15.43	19.23	4.82	0.64	33.93	0.223
V_5 = Pusa Ruby	16.24	18.11	4. 50	0.68	33.01	0.228
V_6 = Pusa Early Dwarf	15.99	17.16	4.71	0.66	33.22	0.235
C.D. (P = 0.05)	0.55	1.00	0.05	0.01	0.87	0.012
Salinity						
S_1 = 1.2 EC dSm^{-1}	22.59	24.44	4.17	0.53	28.34	0.125
S_2 = 3.0 EC dSm^{-1}	18.94	22.12	4.26	0.61	30.09	0.173
S_3 = 5.0 EC dSm^{-1}	15.84	18.23	4.53	0.68	33.00	0.212
S_4 = 7.0 EC dSm^{-1}	13.16	16.24	4.97	0.74	37.15	0.309
S_5 = 9.0 EC dSm^{-1}	10.02	14.91	5.57	0.78	40.23	0.368
C.D. (P = 0.05)	0.50	0.92	0.05	0.01	0.80	0.011
Interaction (V x S)						
C.D. (P = 0.05)	0.55	2.25	0.12	0.03	NS	0.026
C.V. %	4.63	7.2	1.57	2.75	3.54	6.82

A significant difference among varieties of tomato was observed for proline content (mg %) of tomato plant. In general, variety Coimbatore-3 (V_3) gave the maximum proline (0.253 mg %) and it was at par (0.247mg%) with Gujarat Tomato-1 (V_1). These findings are in conformity with the results of El *et al.* (3) in tomato. Irrespective of the variety, the effect of saline irrigation water on proline (mg %) of tomato plant was significant and proline content gradually increased as concentrations of saline irrigation water increased (Table 2). The increase in proline content of tomato plant was more pronounced above 5.0 dSm^{-1}, EC of irrigation water. The highest salt concentrations (9.0 dSm^{-1}) gave highest proline (0.368 mg %) content in tomato plant. Understanding the biosynthesis, degradation, transport and role of proline during stress and signalling events that regulate stress induced accumulation is vital in developing plants for stress tolerance. An increased proline level is a common response of plants to stress treatments reported by Jaleel *et al.* (5) in tomato. Variety Coimbatore-3 (V_3) at highest saline level (9.0 dSm^{-1}) gave maximum proline content and it was found at par with Gujarat Tomato-1 (V_1) and Junagadh Tomato-3 (V_2). These results are in conformity with the results of El *et al.* (3) in tomato.

It is therefore, concluded that salt concentrations in saline irrigation water adversely affected the growth, flowering and yield parameters of tomato varieties under study. However, effect at low level of salt concentration in saline irrigation water was not much pronounced. Among the six varieties the Pusa Ruby proved to be the best for plant height, number of branches, first flower and proline content. The variety Junagadh Tomato-3 also produced maximum productive span, number of fruits, total weight of fruits per plant, fruit diameter, single fruit weight and quality parameters (TSS, acidity, ascorbic acid and sugar) in fruit with combination of 1.2 dSm^{-1}, salt concentration (control), as well as with all other salt concentrations in saline irrigation water. In saline conditions, the variety Junagadh tomato-3 can be grown up to 3.0 to 5.0 dSm^{-1} salt concentration but, with less than 20 and 50 per cent reduction in yield, respectively.

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