Pak.J.Bot., 24(1): 35-39, 1992.

SALINITY TOLERANCE IN TOMATO

S.M.E. SATTI AND RAFIQ AHMAD*

Department of Plant Sciences,
College of Agriculture, Sultan Qaboos University,
Muscat, Sultanate of Oman.

Abstract

Growth and fruiting of five cultivars of tomato viz., Tropic, Pearson, Monte Carlo, ACE-55 and Strain B were studied at different salinity levels ranging between 34-272 mM NaCl. Reduction in growth at lower salinities (34 mM NaCl) was less in comparison to high salinity levels (> 68 mM NaCl). Cv. Tropic produced the highest vegetative biomass under control condition but gave least reproductive yield in terms of fruit weight per plant. However, maximum fruit weight per plant was observed at 34 mM NaCl level. At moderate salinity level (68 mM NaCl), cv. ACE- 55 produced the highest fruit weight though showing a reduction of about 65.91% as compared to control. Highest reproductive biomass was produced in cv. Tropical at 272 mM NaCl which was 25 times less than its control.

Introduction

Saline conditions is known to exist in Sultanate of Oman, especially in closed drainage basins and coastal areas in the Batinah region. Salinization of soil and underground intrusion of saline water has resulted in the decline in productivity at many farms. One feasible approach for increasing the salinity tolerance of crop plants is through plant breeding (Jones, 1986). In tomato, salt tolerant characters are known to exist among wild (Tal & Shannon, 1983) and primitive cultivars (Jones *et al.*, 1988). Although selection of these traits and hybridization with cultivated types are being developed (Jones & Qualset, 1984) but cultivars that are resistant to salt have not yet been released. Selection of most salt tolerant cultivar (s) among the available genome is another useful device in saline agriculture. Studies of plant responses and performance under salinity stress is of practical and economic significance for selecting genotypes that could give feasible yield. A study was therefore initiated to screen the salt tolerant tomato cultivars which could be grown at coastal areas using saline water for irrigation and to determine the level of salinity in irrigation water which can support reasonably good growth.

Materials and Methods

Five cultivars of tomato (*Lycopersicon esculentum* Mill) viz., Tropic, Pearson, Monte Carlo, ACE 55 and Strain B were used. The seeds were sown in germination tray containing perlite and the seedlings transplanted at four leaf stage in pots filled with coastal sand. The pots were irrigated with half strength Hoagland solution supplemented with 0; 34 (EC 3.3 $dS.m^{-1}$); 68 (EC 6.6 $dS.m^{-1}$); 136 (EC 9.8 $dS.m^{-1}$) and 272 (EC 24.6 $dS.m^{-1}$) mM NaCl concentrations.

*Visiting Professor, College of Agriculture, Sultan Qaboos University, Muscat, Sultanate of Oman.

Present Address: Department of Botany, University of Karachi, Karachi-75270, Pakistan.

Table 1. Effect of salinity levels on the vegetative growth (per plant) of tomato plants.

Salinity levels (mM NaCl)	Height (cm)	Leaf (cm)	Fresh weight (g)		Dry weight (g)	
			Root	Shoot	Root	Shoot
0	86.90 a	17.25 a	17.76 a	173.98 a	4.69 a	39.88 a
34	84.10 ab	17.72 a	10.01 b	149.86 a	2.92 b	32.35 b
68	78.55 b	16.82 a	6.05 b	91.26 b	1.87 c	21.42 c
136	61.03 c	14.60 b	2.01 bc	21.09 c	1.10 cd	10.58 d
272	45.25 d	13.07 c	0.78 c	5.93 c	0.48 d	4.14 e

Means within a column having the same letter are not significantly different from each other at 5% level.

The experiments were performed in greenhouse under natural day length with mean day and night temperatures of 28 and 18°C, respectively. The experiment was carried out using randomized complete block design with eight replications. Each block had twenty five plants with 5 cultivars x 5 salt treatments. Pots were leached fortnightly and the leachate was reused in their respective pots in subsequent irrigation. Observation were taken on different vegetative and reproductive growth parameters and analysed by Duncan's multiple range test.

Results and Discussion

Irrigation of tomato plant species under culture solution supplemented with 34,68, 136 and 272 mM NaCl supressed vegetative as well as reproductive growth. Preliminary analyses of the data showed non-significant differences between the different cultivars and significant differences between different salinity levels. In order to see the over all effects of different salinity levels on various growth parameters, means were calculated for each cultivar and further analysed. There was a sharp decrease in both fresh and dry biomass of plants from 68 mM NaCl (Table 1). Decline in reproductive growth was gradual up to 136 mM NaCl. Concentration of total soluble solids increased with increase in salinity levels (Table 2). Comparative performance of vegetative growth of

Table 2. Flowering, fruit set and quality of tomato in response to salinity levels.

Salinity levels (mM NaCl)	Number * of Flowers	Fruit set %	Fruit Yield		Total Soluble Solids (%)
			Weight (g)	Number	
0	15.27 a	58.09 a	594.62 a	7.55 a	4.84 a
34	13.42 b	52.41 ab	367.12 b	6.67 a	7.07 b
68	14.07 ab	51.31 ab	271.47 c	6.97 a	8.11 c
136	11.77 c	45.62 b	118.27 d	5.32 b	9.18 d
272	7.57 d	23.39 c	14.14 e	1.55 c	10.99 e

Means within a column having the same letter are not significantly different from each other at 5% level.

* Based on total number of flowers of the first 3 clusters.

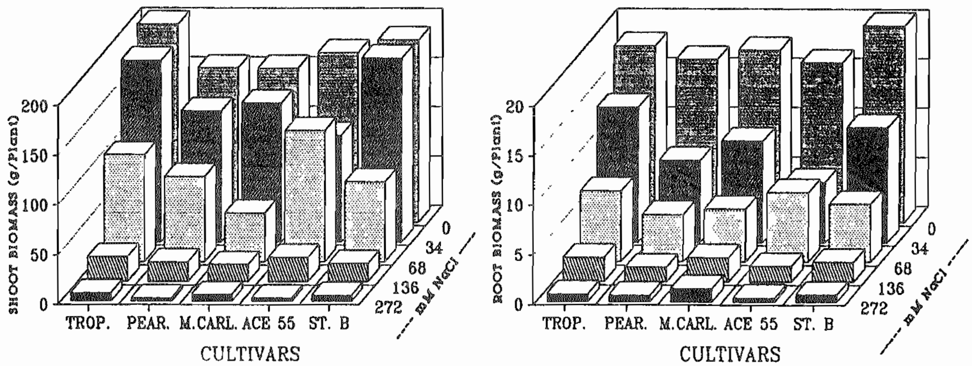

Fig.1. Effect of salinity on the vegetative biomass of different tomato cultivars.

all the cultivars at various salinity levels is shown in Fig.1. Variation in total fruit weight of cultivars at different salinity levels is given in Table 3. The degree of inhibition in growth appears to be directly proportional to the increase in salt concentration of culture solution (Fig.1). Growth and yield parameters are reported to be negatively correlated with increasing salinity for many crop plants (Epstein, 1980). In general salinity increases the amount of work necessary to counteract osmotic and ionic stresses for normal cellular growth (Nieman, 1962). Difference in Na^+ substitution capacity have been reported to account for less effeciency and poor adoptation to NaCl stress (Figdore *et al.*, 1987; Mundy, 1983; Marschner, 1981).

Comparative performance of all the cultivars for various vegetative/reproductive parameter is further illustrated in Table 4 at 68 and 272 mM NaCl salinity regimes. Cv. Tropic was found to excel from others in vegetative biomass production under non-saline condition, but it gave least reproductive yield in terms of fruit weight per plant. It appears that a good amount of photosynthate in this cultivar is wasted in producing vegetative parts of the plant. In this cultivar the foliage still supplies a good amount of photosynthate to produce highest fruit weight at 34 mM NaCl (Table 3). Cultivar ACE-55 which occupies middle position among all the five cultivars with reference to vegetative growth under control (non-saline) condition, produced highest weight of fruits per plant. Cultivar ACE-55 having produced a fruit weight of 289.22 g per plant at 68 mM NaCl

Table 3. Effect of salinity levels on fruit weights of different tomato cultivars.

	Salinity level (mM NaCl)				
Cultivars	0	34	68	136	272
Tropic	549.31 a	399.27 b	270.09 c	149.95 d	20.89 e
Pearson	602.24 a	369.19 b	234.93 c	135.71 d	10.97 e
Monte carlo	565.68 a	359.44 b	272.36 c	93.26 d	7.77 e
ACE 55	662.54 a	352.38 b	289.22 b	98.59 c	12.87 d
Strain B	593.32 a	355.29 b	281.76 b	113.87 c	19.73 d

Means within a row having the same letter are not significantly different from each other at 5% level.

Table 4. Comparative performance of different cultivars under various salinity levels.

Fresh Biomass (Shoot)									
68 mM NaCl	ACE 55	>	Tropic	>	Pearson	>	Strain B	>	Mon.Carl.
272 mM NaCl	Tropic	>	Mon.Carl.	>	Strain B	>	Pearson	>	ACE 55
Fresh Biomass (Root)									
68 mM NaCl	ACE 55	>	Tropic	>	Pearson	>	Strain B	>	Mon.Carl.
272 mM NaCl	Tropic	>	Strain B	>	Mon.Carl.	>	Pearson	>	ACE 55
Total Fruit/Plant									
68 mM NaCl	Mon. Carl	>	ACE 55	>	Pearson	>	Strain B	>	Tropic
272 mM NaCl	Str. B	>	Tropic	>	Pearson	>	Mon.Carl	>	ACE 55
Fruit weight/Plant									
68mM NaCl	ACE 55	>	Strain B	>	Mon.Carl.	>	Tropic	>	Pearson
272mM NaCl	Tropic	>	Strain B	>	ACE 55	>	Pearson	>	Mon.Carl.

appears to be the best cultivar in respect of reproductive growth, at this salinity level followed by Strain B, Monte Carlo, and Tropic. At 272 mM NaCl, Cv. Tropic produced comparatively higher vegetative growth and also managed to give higher weight of fruits per plant. The weight of fruits/plant in cultivar Tropic was reduced by 50.83 and 96.19% at 68 and 272 mM NaCl levels, respectively, whereas, in cultivar ACE 55 the yield was reduced by 56.35 and 98.05% at these levels, respectively. On the bases of yield per plant, under non-saline and at 68 mM NaCl, Cv. ACE-55 showed comparatively better performance. Cv. Tropic which showed greater salt tolerance at 272 mM NaCl showed very poor yield in terms of fruit weight/plant.

Utilization of saline water at coastal sandy belt in crop production has become a very important issue for developing countries where good quality water is not available (O'Leary, 1984; Ahmad *et al*., 1986). Cultural techniques and selection of salt tolerant cultivars appear to be the most important considerations when undertaking saline agriculture. Tomato appears to be very sensitive at higher salinity levels of 272 mM NaCl. Reduction in yield in certain cultivars at lower salinity levels of 132 and 64 mM NaCl could still be within economically permissible limit for undertaking cultivation at moderately saline conditions.

References

Ahmad, R., S. Ismail and D. Khan. 1986. Use of highly saline water for irrigation at sandy soil. In: *Prospects for Biosaline Research* (Eds.) R. Ahmad and A. San Pietro, Proc., US. Pak. Biosaline Res. Work., Karachi, pp.387-411.

Epstein, E. 1980. Responses of plants to saline environments. In: *Genetic Engineering of Osmoregulation* (Eds.) D.W. Rains, R.C. Valentine and A. Hollander. Plenum Press N.Y., pp 7-21.

Figdore, S.S., W.H. Gableman and G.C. Gerloff. 1987. The accumulation and distribution of sodium in tomato strains differing in potassium efficiency when grown under low-K stress. *Plant & Soil,* 99: 85-92.

Jones, R.A. 1986. Genetic advances in salt tolerance. In: *Tomato Biotechnology* (Eds.) D.J. Nevins and R.A. Jones. Alan R. Liss. Pub. New York.

Jones, R.A., M. Hashim and A.S. El-Beltagy. 1988. Developmental responses of salt tolerant and salt sensitive genotypes of *Lycopersicon*. In: *Arid Lands: Today and Tomorrow* (Ed.) E. Whitehead. West View Press, Colorado.

Jones, R.A. and C.O. Qualset. 1984. Breeding for environmental stress tolerance. In: *Applications of Genetic Engineering to Crop Improvement* (Eds.) G.B. Collins and J.F. Petolino. Nijhoff/Junk, Pub. Dordrecht.

Marschner, H.; P.J.C. Kuiper and A. Kylin. 1981. Genotypic differences in the response of sugar beet plants to replacement of potassium by sodium. *Physiol. Plant.,* 51: 239-244.

Mundy, G.N. 1983. Effects of potassium and sodium concentrations on growth and cation accumulation in pasture species grown in sand culture. *Aust. J. Agric. Res.,* 34: 469-481.

Neiman, R.H. 1962. Some effects of sodium chloride on growth, photosynthesis and respiration of twelve crop plants. *Bot. Gaz.,* 123: 279-285.

O'Leary, J.W. 1984. The role of halophytes in irrigated agriculture. In: *Salinity tolerance in plants.* (Eds.) R.C. Staples and G.H. Toenniessen. John Wiley and Sons, New York.

Tal, M. and M.C. Shannon. 1983. Salt tolerance in the wild relative of the cultivated tomato. *Aust. J. Pl. Physiol.,* 10: 109- 117.

(Received for Publication 15 February 1992)