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Effects of Salt Regimes on Growth and Mineral Uptake of Pomegranate (*Punica granatum* L.) cv. Mrudula

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Abstract: Effects of salt regimes on mortality, growth and mineral uptake of pomegranate were studied. 3-month-old air layers of pomegranate cv. Mrudula were grown for 8 months in artificially salinized soils having ECe levels of 0.77, 3, 6, 9, 12 and 15 dS m^{-1} each of NaCl and Na_2SO_4 salts. It was observed that the plant survival and plant growth was satisfactory upto ECe 6 dS m^{-1}. However, plant mortality and growth suppression was drastic at ECe 9 dS m^{-1} and above. With the increase in soil ECe, there was decrease in nitrogen, phosphorus, potassium, calcium and magnesium content of leaves, while sodium and chloride content of leaves increased with increasing soil salinity. Thus, the nutritional imbalance could occur in pomegranate due to salinity.

Key words: Pomegranate, growth, NaCl, Na_2SO_4 salinity, soil ECe, mineral composition.

Pomegranate is one of the favorite fruits of tropical and subtropical regions. It withstands considerable extent of drought with steady and higher yields, early bearing, low maintenance cost. The fruits have better keeping quality. It is also adaptable to a wide range of soil and climatic conditions and is a hardy plant.

Pomegranate can be successfully grown in dry regions. The soils from dry regions usually have high salt content. Further use of canal irrigation and subsoil brackish water for irrigation has resulted in soil salinization. In India, about seven million hectares land is affected by salinity or alkalinity. Reclamation of salt affected soil is not practically feasible for several reasons. Hence, the feasible alternative left with the farmers is to grow salt tolerant crops. However, the complete knowledge about level of salt tolerance of pomegranate is practically not available, particularly for the newly developed cv. Mrudula. Salinity also alters the nutrient composition of the plant. This information is also not adequately available in pomegranate. The present study was therefore, under taken to investigte the effects of salt regimes on growth and mineral uptake in pomegranate.

Materials and Methods

The experiment was conducted in pot culture at the Instructional-cum-Research Orchard, Department of Horticulture, Central Campus Mahatma Phule Krishi Vidyapeeth, Rahuri. 3-month-old air layers of pomegranate cv. Mrudula were used. Normal sandy loam soil was brought from the river bank. The soil was air dried in shade and passed through 2 mm sieve. The soil was collected and analyzed for mechanical and chemical properties. Earthen pots of 9 kg capacity were lined with black polythene before filling. The soils were artificially salinized to ECe levels

of 3, 6, 9, 12 and 15 dS m^{-1} with each of NaCl and Na_2SO_4 salts. The control soil had the salinity level of 0.77 dS m^{-1}.

The experiment was laid out in a factorial completely randomized design with 12 levels comprising of two salts (NaCl and Na_2SO_4) and six levels of each salt having three replications. The observations were recorded on various plant growth parameters and nutrient content.

Results and Discussion

Growth

The data pertaining to plant mortality as on 240th day as influenced by different levels of NaCl and Na_2SO_4 were statistically significant due to the salinity levels and the salt type (Table 1). The interaction effects were non-significant. The plant survival was adversely affected by soil salinity. The mean plant mortality on 240th day was 44.44% for NaCl and 27.77% for Na_2SO_4. No plant mortality was evident upto 6 ECe salinity. At 9, 12 and 15 ECe mortality was 33.33, 83.33 and 100%, respectively. Thus, no plant mortality was recorded upto 6 ECe level of NaCl and 9 ECe level of Na_2SO_4. The mortality was 100% at 12 ECe level of NaCl and 15 ECe level of Na_2SO_4. Hence, it could be inferred that NaCl was more harmful than Na_2SO_4.

Table 1. Effect of salts and the salinity levels on plant mortality (%) as on 240th day

Salinity (dS m^{-1})	Salt		
	NaCl	Na_2SO_4	Mean
0.77	0.00	0.00	0.00
3.0	0.00	0.00	0.00
6.0	0.00	0.00	0.00
9.0	66.66	0.00	33.33
12.0	100.00	66.66	83.33
15.0	100.00	100.00	100.00
Mean	44.44	27.77	36.11
	SEm±	CD (5%)	
Salinity level	9.622	27.761	
Salt type	5.556	16.028	
Interaction (level x salt)	13.608	NS	

Plant height

The effects of salinity levels on in plant height were statistically significant (Table 2). The mean plant height on 120th day was 40.17 cm for NaCl and 43.11 cm for Na_2SO_4. The plants could tolerate both the salts upto 6 ECe without much reduction in height.

The mean plant height at different salt levels varied from 27.66 to 53.66 cm. The lowest plant height (27.66 cm) on 120th day was recorded at 15 ECe. The interaction effects due to soil salinity levels and the salts on plant height were significant.

Stem diameter

The differences in stem diameter were statistically significant (Table 2). The mean stem diameter on 120th day was 2.77 mm for NaCl and 2.86 mm for $NaSO_4$. The pomegranate plant could tolerate NaCl upto 6 ECe and Na_2SO_4 upto 9 ECe without much effect on stem diameter. The mean stem diameter at different salt levels varied from 2.43 to 3.10 cm. The higher salt concentration had adverse effect on stem diameter.

Number of leaves

The differences in the number of leaves per plant were statistically significant (Table 2). The mean total number of leaves was 50.60 for NaCl and 54.55 for Na_2SO_4.

Table 2. Effect of the salts and the salinity levels on growth of pomegranate cv. Mrudula as on 120th day

Salinity ($dS\ m^{-1}$)	Plant height (cm)			Stem diameter (mm)			Leaves/plant			Total leaf area (cm^2)			No. of shoots		
	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean
0.77	53.33	53.66	53.66	3.10	3.10	3.10	75.66	75.66	75.66	140.00	140.00	140.00	11.66	11.66	11.66
3.0	51.66	52.33	51.50	3.00	3.06	3.03	65.33	70.66	68.00	128.66	138.33	133.50	9.66	10.33	10.00
6.0	50.66	51.66	51.66	2.96	3.00	2.98	61.33	68.33	64.83	122.66	133.33	128.00	9.33	9.66	9.50
9.0	35.33	38.66	37.00	2.63	2.83	2.73	39.66	44.00	41.83	77.66	95.33	86.50	5.33	5.66	5.50
12.0	28.66	31.66	30.16	2.56	2.70	2.63	32.66	36.66	34.66	65.00	71.00	68.00	4.33	4.66	4.50
15.0	24.66	30.66	27.66	2.36	2.50	2.43	29.00	32.00	30.50	68.66	62.66	60.66	3.33	3.33	3.50
Mean	40.17	43.11	41.69	2.77	2.86	2.81	50.60	54.55	52.08	98.77	107.77	102.61	7.27	7.61	7.36
	SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)	
Salinity level	0.527	1.520		0.0311	0.0899		1.080	3.116		1.140	3.290		0.333	0.961	
Salt type	0.304	0.877		0.0180	0.0519		0.623	1.799		0.658	1.899		0.192	0.555	
Interaction (level x salt)	0.745	2.150		0.0440	NS		1.527	NS		1.613	4.653		0.471	NS	

Table 3. Effect of the salts and the salinity levels on N, P, K, Ca and Mg concentration (%) in leaves of pomegranate cv. Mrudula as on 120th day

Salinity (dS m^{-1})	N			P			K			Ca			Mg		
	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean
0.77	1.980	1.980	1.980	0.351	0.351	0.351	2.247	2.247	2.247	1.844	1.844	1.844	0.657	0.657	0.657
3.0	1.814	1.654	1.734	0.283	0.317	0.300	2.086	2.148	2.117	1.779	1.683	1.736	0.585	0.584	0.585
6.0	1.714	1.583	1.649	0.268	0.291	0.279	1.994	2.049	2.022	1.611	1.587	1.599	0.534	0.489	0.512
9.0	1.645	1.541	1.593	0.243	0.276	0.259	1.593	1.981	1.967	1.603	1.494	1.548	0.482	0.399	0.440
12.0	1.605	1.409	4.507	0.230	0.246	0.238	1.888	1.851	1.870	1.528	1.445	1.486	0.426	0.359	0.392
15.0	1.578	1.330	1.454	0.166	0.163	0.165	1.714	1.770	1.742	1.415	1.192	1.303	0.288	0.272	0.280
Mean	1.723	1.582	1.634	0.256	0.274	0.262	1.980	2.008	1.986	1.632	1.540	1.575	0.495	0.460	0.477
	SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)		SEm±	CD (5%)	
Salinity level	0.0172	0.0497		0.00836	0.0241		0.0264	0.0761		0.0202	0.0583		0.0195	0.0564	
Salt type	0.0099	0.0287		0.00482	0.0139		0.0152	0.0439		0.0116	0.0337		0.0112	0.0325	
Interaction (level x salt)	0.0243	0.0703		0.0118	NS		0.0373	NS		0.0286	0.0825		0.0276	NS	

Table 4. Effect of the salts and the salinity levels on Na and Cl concentration (%) in leaves of pomegranate cv. Mrudula as on 120th day

Salinity levels ECe (dS m^{-1})	Na			Cl		
	NaCl	Na_2SO_4	Mean	NaCl	Na_2SO_4	Mean
0.77	0.118	0.118	0.118	0.120	0.120	0.120
3.0	0.216	0.201	0.209	0.469	0.133	0.301
6.0	0.293	0.228	0.260	0.526	0.163	0.345
9.0	0.379	0.309	0.344	0.611	0.175	0.393
12.0	0.433	0.379	0.411	0.647	0.210	0.429
15.0	0.519	0.439	0.479	0.723	0.217	0.470
Mean	0.328	0.280	0.303	0.516	0.170	0.365
	SEm±	CD (5%)		SEm±	CD (5%)	
Salinity level	0.0264	0.0762		0.0218	0.0370	
Salt type	0.0152	0.0440		0.0074	0.0214	
Interaction (level x salt)	0.0373	NS		0.0181	0.0524	

The mean number of leaves per plant varied from 30.50 to 75.66. The drastic reduction in leaf number per plant was seen at salt level of 9 ECe and above.

Leaf area

The salinity level and salts had significant effect on leaf area per plant (Table 2). The mean total leaf area at 120^{th} day was 98.77 cm^2 for NaCl and 107.77 cm^2 for Na_2SO_4. At different salt levels it varied from 60.66 to 140 cm^2. There was drastic reduction in leaf area per plant at 9 ECe and above. The total leaf area decreased with increase in the level of salinity and the decrease was statistically significant.

Number of shoots

The differences in number of shoots per plant due to salinity levels and salt were statistically significant (Table 2). The mean number of the shoots was 7.27, for NaCl and 7.61 for Na_2SO_4 and at different salt levels it varied from 3.50 to 11.66. There was reduction in number of shoot at 9 ECe and above.

Significant reduction in growth parameters namely plant height, stem diameter, number of leaves, leaf area and number of shoots were observed at higher salinity levels. Reduction in various growth parameters due to soil salinity has been reported by Patil and Patil (1982), Patel and Waghmare (1983); Doring and Ludders (1986), Sharma *et al.* (1987); Deshmukh (1996).

Mineral composition

The concentrations of nitrogen, phosphorus, potassium, calcium, magnesium, sodium in the leaves of pomegranate were significantly influenced by the salinity levels and salt type. The nitrogen concentration (Table 3) decreased significantly from 1.98 to 1.45% with the increase in level of salinity. Similarly the phosphorus, potassium, calcium, magnesium concentrations in the leaves of

pomegranate were also reduced due to salinity. The phosphorus concentration (Table 3) decreased from 0.351 to 0.165% potassium content (Table 3) decreased from 1.84 to 1.30% and the magnesium content decreased from 0.66 to 0.28% (Table 3).

The sodium concentration increased from 0.118 to 0.479% with the increase in the level of soil salinity and the chloride concentration increased from 0.120 to 0.470% (Table 4).

The findings revealed that chloride salinity is more toxic than sulphate salinity; and that the growth and nutrition balance of plant is affected by different salt regimes are in line with results of other researchers working on various fruit crops (Desai and Singh, 1979; Dhankar *et al.*, 1980; Dhiya and Dhankhar, 1982; Deshmukh, 1996). It is concluded that, pomegranate tolerates sodium chloride upto ECe 6 dS m^{-1} and sodium sulphate upto ECe 9 dS m^{-1} without mortality and gives satisfactory growth.

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