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Standardization of mango rootstock for mitigating salt stress

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ABSTRACT

Seedlings of different mango varieties were tested against different EC levels of water developed by several salt compositions. Seedlings from stone of Kesar variety was found better with significantly highest survival percentage, germination percentage and growth parameters. Significantly more mortality of seedling was observed in Totapuri variety. In case of EC level of water, significantly highest survival percentage was registered only at 1.20 dSm^{-1} EC level. Poor seedling survival (14.12%) could be' recorded at 4.00 dSm^{-1} EC level of water. Germination percentage, number of leaves, plant height and root length were increased with decreasing EC level. The accumulation of sodium was found to be higher in leaves, whereas, potassium and Na: K ratio were noted lower with higher EC level. The interaction effect of days to germination, number of leaves, root length, survival percentage, Na content and Na:K ratio were found significant.

Key words: Rootstock, mango, salinity, sodium, potassium, salt stress.

INTRODUCTION

Mango (*Mangifera indiaca* L.)is one of the most important fruits of country. This fruit crop is known as 'King of fruits' due to its pleasant characteristics. It is grown in many states on an area of 2.20 m ha land and total production of 13.79 m tonnes with 6.30 M t/ha productivity (Anon,1). The salinity hazard is increasing day by day in India and a large portion of geographical area could not be taken under cultivation.

The salt affected soils in India are reaching over 8.5 m ha area. The salt levels vary with proportion of different salts. In some area, chloride is dominant, while another sulphate or carbonate salts are dominating (Singh *et al.,* 11). The composition of different salts in soil have varying l detrimental effects on plant growth. The plant species, kind of salts and its salinity affects the intensity of damage to plant. Mango is more sensitive to salinity particularly at early stage of growth and hence, it is becoming the risk for successful cultivation of mango. Therefore, there is a greater need to standardize the salt tolerant rootstock for successful mango cultivation. Very little efforts have been made to identify mango variety as a rootstock tolerant to different composition of salts under Gujarat conditions. Therefore, an investigation was carried out to standardize salt tolerant rootstock in mango.

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MATERIALS AND METHODS

Present investigation was carried out to standardize the mango root stock through seedling of different varieties of mango and EC levels of water at Fruit Research Station, Madhadibag Farm, Department of Horticulture, College of Agriculture, Junagadh Agril. University, Junagadh (Gujarat) during 2005 to 2007. Total 16 combinations were comprising of four varieties, *viz*., Kesar (V1), Rajapuri (V_2), Totapuri (V_3) and Ashadhiyo (V_4) with four EC levels of irrigation water, *viz*., 1.2 EC dSm^{-1} (W_1), 2.0 EC dSm^{-1} (W_2), 3.0 EC dSm^{-1}(W3) and 4.0 EC dSm^{-1}(W_4). The experiment was laid out in Factorial Randomized Block Design with three replication. Fruits of above varieties were collected in July and seeds were sown in the nursery in pots after treatment with bavistin.

The experiment was taken under shadehouse in pot. The pots were filled with media including soil and well decomposed farm yard manure. The stones of different varieties were planted as per treatment during June-July and the irrigation water was given as per the EC levels. Computed amount of salts were dissolved in distilled water and prepare a required EC levels of water poured into pots as per treatment. The treatment with irrigation water was started after planting of stones. The plants were allowed for one year growth and necessary observations were recorded. Mineral composition (Na, K and Na:K ratio) of leaves was assessed under laboratory conditions by using standard procedures.

RESULTS AND DISCUSSION

The plant growth parameters were significantly influenced by different varieties and EC levels of water (Table 1). Significantly maximum germination (66.18%) was recorded in variety Kesar (V_1) followed by Ashadhiyo (V_4). This may be due to genetic make up of the varieties Kesar and Ashadhiyo. Similar result was obtained by Hussain *et al.* (7) in variety Samar Bahisht. In case of EC dSm^{-1} level, highest germination (62.38%) was noted with irrigating the pot with W_1 (EC 1.2 dSm^{-1}) level of water. However, it was found at par with 2.0 EC dSm^{-1} level of water (W_2). The poor germination percentage was recorded with higher EC of water. Generally, mango is more sensitive to salinity during germination and early seedling growth due to increase in the osmotic pressure of the soil solution or toxicity to the embryo or the growing seedling. Similar trend was observed for days to germination, and minimum (29.95 days) was registered in Kesar (V_1), but was found at par with Ashadhiyo (V_4). Among EC levels, lowest days to germination (32.59) was noted in EC 1.2 dSm^{-1} level of water (W_1) followed by 2.0 EC dSm^{-1} level of water (W_2). The germination was delayed under higher EC levels. The interaction effect was also observed significant in which minimum days to germination (24.29 days) were registered in variety Kesar with EC 1.2 dSm^{-1} level of water (V_1W_1).

Significantly, the highest number of leaves and plant height (8.79 & 25.63 cm, respectively) were also recorded in variety Kesar (V_1). The result was found in conformity with those of Hussain *et al.,* (7) in variety Samar Bahisht, Nigam and Misra (10) in cultivar Hybrid 15/1. For EC level of water, significantly maximum number of leaves and plant height (10.22 & 25.21 cm, respectively) were found with EC 1.2 dSm^{-1} level of water, but were observed at par with 2.0 EC dSm^{-1} level of water. The interaction effect was also found significant for number of leaves only and highest (11.47) was noted in variety Rajapuri with EC1.2 dSm^{-1} (V_2W_1). The poor growth in higher salinity because the salinity in soil is harmful at all stages of growth and development of the plant. The growth stunting and retardation is the most common effect of salt stress on all growth parameters are reduced.

The similar result was obtained by Nigam and Misra (10), Gupta and Sen (6) in mango. Similarly, the root length and girth were recorded significant, whereas the stem diameter was found non significant (Table 2). Significantly maximum root length and girth (23.01 & 3.17 mm) were noted in varieties Kesar and Rajapuri, respectively. Among the EC level, highest root length (20.82 cm) was noted with EC 1.2 dSm^{-1} level of water and was found at par with EC 2.0 dSm^{-1} level, whereas, minimum root growth was recorded in 4.0 dSm^{-1} level of

Table 1. Effect of root stocks and EC level of water (dSm^{-1}) on germination percentage, days to germination, number of leaves and plant height in mango.

Treat.	Germination (%)				Days to germination				No. of leaves				Plant height (cm)			
	2005	2006	2007	pooled	2005	2006	2007	pooled	2005	2006	2007	pooled	2005	2006	2007	pooled
Variety																
V_1	67.71	67.71	65.28	66.18	21.03	38.89	29.93	29.95	10.90	7.02	8.44	8.79	27.11	25.93	23.86	25.63
V_2	42.75	45.83	39.58	42.72	26.83	48.82	44.26	39.97	11.32	4.45	8.91	8.23	29.47	22.94	24.30	25.57
V_3	41.67	42.71	36.46	40.28	32.08	50.21	43.91	42.07	7.58	4.40	7.89	6.63	13.03	19.28	15.75	16.02
V_4	67.71	63.54	48.61	59.95	23.00	36.49	37.74	32.41	8.22	6.36	8.18	7.58	22.85	24.90	22.88	23.54
CD at 5%	10.68	11.87	7.34	5.93	1.79	2.19	3.21	3.26	0.77	0.49	0.37	1.44	1.08	2.25	1.28	3.31
EC level (dSm^{-1})																
W_1	65.63	62.50	59.03	62.38	23.53	40.71	33.54	32.59	13.54	6.05	11.07	10.22	25.79	25.40	24.44	25.21
W_2	57.29	59.38	52.78	56.48	24.92	44.47	39.77	36.39	12.25	5.57	10.32	9.38	24.33	24.70	23.61	24.21
W_3	51.04	50.00	42.71	47.92	25.08	43.18	40.99	36.42	7.93	5.25	6.69	6.62	22.82	22.90	20.80	22.17
W_4	45.88	47.92	35.42	43.07	29.42	46.06	41.54	39.01	4.29	5.37	5.35	5.00	19.52	20.04	17.95	19.17
CD at 5%	10.68	11.87	7.34	5.93	1.79	2.19	3.21	1.44	0.77	0.49	0.37	2.40	1.08	2.25	1.28	0.95
Interaction V X W																
CD at 5%	NS	NS	14.68	NS	3.58	4.38	6.42	4.43	1.54	NS	0.74	1.33	2.16	NS	NS	NS
CV (%)	23.44	26.06	18.66	24.09	8.39	6.06	9.94	8.52	9.77	10.65	5.36	9.08	5.63	11.68	7.09	8.88

Table 2. Effect of root stocks and EC level of water (dSm^{-1}) on root length, root girth, stem diameter and survival percentage in mango.

Treat.	Root length (cm)				Root girth (mm)				Stem diameter (mm)				Survival percentage (%)			
	2005	2006	2007	pooled	2005	2006	2007	pooled	2005	2006	2007	pooled	2005	2006	2007	pooled
							-Variety									
V_1	18.94	26.03	24.06	23.01	2.29	3.79	3.14	3.07	5.28	5.16	4.49	4.98	56.23	56.25	52.50	55.23
V_2	20.03	14.04	22.17	18.75	2.28	3.34	3.89	3.17	6.21	4.25	4.29	4.92	33.33	16.67	27.08	25.69
V_3	19.67	12.90	20.02	17.53	1.66	2.87	3.56	2.70	5.07	3.69	4.21	4.32	24.99	12.50	21.88	19.79
V_4	17.08	17.84	21.596	18.84	1.91	2.94	3.17	2.67	5.58	3.86	4.47	4.64	41.66	40.63	37.50	39.93
C.D at 5%	1.35	1.32	1.12	4.03	NS	0.50	NS	0.41	NS	0.31	0.23	NS	8.46	7.62	8.51	4.79
							EC level (dSm^{-1})									
W_1	19.72	18.96	23.79	20.82	2.20	3.55	3.53	3.10	6.33	4.57	4.49	5.13	61.10	56.25	53.54	56.96
W_2	19.13	17.14	23.30	19.85	1.99	3.17	3.10	2.75	5.13	4.21	4.46	4.60	40.27	36.46	39.58	38.77
W_3	17.48	16.42	20.79	18.23	1.99	3.17	3.76	2.98	5.36	4.08	4.38	4.61	36.10	23.96	32.29	30.78
W_4	19.40	18.29	19.96	19.22	1.95	3.05	3.37	2.79	5.33	4.10	4.13	4.52	19.44	9.38	13.54	14.12
CD at 5%	1.35	1.32	1.12	1.26	NS	0.50	NS	NS	NS	0.31	0.23	NS	8.46	7.62	8.51	4.79
							Interaction V X W									
CD at 5%	2.71	2.64	2.25	3.78	NS	NS	NS	NS	NS	NS	NS	NS	16.91	15.25	17.01	9.68
CV(%)	8.62	9.00	6.17	8.10	35.34	18.57	33.45	30.47	37.97	4.90	6.43	27.24	24.01	29.20	29.54	28.24

Table 3. Effect of rootstocks and EC level of water (dSm^{-1}) on Na, K and Na:K ratio in mango.

Treat.	Na (%)				K (%)				Na:K ratio			
	2005	2006	2007	pooled	2005	2006	2007	pooled	2005	2006	2007	pooled
						Variety						
V_1	1.070	1.080	1.073	1.074	0.876	0.926	0.888	0.897	1.304	1.200	1.252	1.252
V_2	1.229	1.266	1.287	1.261	0.819	0.870	0.798	0.829	1.506	1.553	1.624	1.561
V_3	1.463	1.496	1.496	1.485	0.614	0.728	0.714	0.685	2.394	2.099	2.135	2.209
V_4	1.129	1.131	1.131	1.130	0.783	0.883	0.829	0.832	1.453	1.345	1.380	1.392
CD at 5%	0.04	0.05	0.047	0.028	0.024	0.037	0.0408	0.0322	0.083	0.070	0.0864	0.102
						EC level (dSm^{-1})						
W_1	0.968	0.983	0.983	0.978	0.852	0.989	0.876	0.905	1.231	1.005	1.151	1.129
W_2	1.157	1.168	1.188	1.171	0.777	0.936	0.831	0.848	1.578	1.292	1.480	1.450
W_3	1.330	1.351	1.351	1.344	0.752	0.786	0.789	0.776	1.779	1.754	1.720	1.751
W_4	1.435	1.473	1.466	1.458	0.711	0.696	0.734	0.714	2.069	2.147	2.039	2.085
CD at 5%	0.04	0.05	0.047	0.028	0.024	0.037	0.0408	0.0556	0.083	0.070	0.0864	0.109
						Interaction VXW						
CD at 5%	0.09	0.11	0.093	0.057	0.047	0.074	0.0815	NS	0.166	0.141	0.172	0.125
CV (%)	4.22	5.34	4.51	4.87	3.67	5.22	6.09	5.30	6.03	5.49	6.52	6.23

water. The result was observed non significant for root girth. The root biomass was found decreasing with the increasing the EC level of water. It might be due to the fact that the salts presents in water and soil solution exerted more toxic effect on roots.

The survival percentage was observed significant during all the years and pooled for both varieties and EC level of water (Table 2). The highest survival percentage (55.23) was recorded in variety Kesar followed by Ashadhiyo (39.35). The mortality of seedlings were found lowest in Kesar and Ashadhiyo may be due to tolerability of the genotypes. Among the EC levels, maximum survival (56.96) was registered with EC 1.2 dSm^{-1} level of water followed by2.0dSm^{-1}. The interaction effect was also found significant and highest (82.96%) in variety Kesar with EC 1.2 dSm^{-1} level of water (V_1W_1) followed by combination V_4W_1 (69.90%). The higher survival percentage with lower EC of water and lower survival percentage with higher EC level of water may be due to toxic effects on plants. The salinity tends to alter the nutritional imbalance, which result in changes in metabolic activities leading to increases in free amino acid, proline, total organic acids and hydrolytic enzymes. Sever salinity resulted in death due to loss of ionic control in root and chlorosis, necrosis and wilting. The toxic effect of ions on the seedlings may also be attributed to its interaction with other mineral nutrients, which may have caused injuries by interfering with normal stomatal closure, causing excess water loss and leaf injury symptoms like those of drought. The poor survival percentage was noted with more saline water and it was supported by Jindal *et al.* (8). These findings are in agreement with that of Khanna and Kumar (9), Srivastav *et al.* (12), and Srivastav *et al.* (13).

There was significant influence of Na & K contents as well as Na:K ratio in the dry leaves (Table 3). Lowest content of Na (1.074%) and Na:K ratio (1.252) with higher content of K (0.897) were recorded in variety Kesar followed by variety Ashadhiyo. It may be due salt tolerance mechanism in Kesar as compared to other varieties, which might have reduced the entrance and accumulation of Na salts in the plant tissue. The result was also in conformity with those of Nigam and Misra (10) reported lower accumulation of Na in Kala Hapus and highest in Gulab Khas. El Defan *et al.* (4) suggested that Sensation was more salt tolerant than Sudani. It was also in conformity with Zuazo *et al.* (3).

Among EC levels, minimum Na content (0.978%) was noted with EC 1.2 dSm^{-1} level of water (W1). Na:K ratio was also with similar trend of Na content. Both were significantly increased with increasing the EC levels. The reverse trend was observed for K content and found to be reduced with increasing the EC level as it was found highest in EC 1.2 dSm^{-1} but lowest in EC 4 (1.2

Table 4. Effect of root stocks and EC level of water (dSm^{-1}) on interaction of days to germination, number of leaves, survival percentage, Na & K content and Na: K ratio in mango.

Treatment	Days to germination	Number of leaves	Survival (%)	Na conc. (%)	Na: K ratio	Root length
V_1W_1	24.29	10.55	82.96	0.637	0.632	21.38
V_1W_2	26.67	10.68	68.05	0.815	0.886	24.54
V_1W_3	31.91	7.16	60.64	1.333	1.555	23.64
V_1W_4	36.93	6.76	9.26	1.513	1.935	22.49
V_2W_1	36.23	11.47	37.50	1.444	1.550	21.65
V_2W_2	41.04	9.56	27.78	0.869	0.986	20.42
V_2W_3	35.86	8.11	24.07	1.434	1.916	18.87
V_2W_4	46.75	3.77	13.42	1.295	1.792	14.06
V_3W_1	40.06	8.43	37.49	1.324	1.761	19.26
V_3W_2	44.59	8.96	15.28	1.764	2.471	15.64
V_3W_3	44.16	5.17	13.89	1.185	1.815	14.03
V_3W_4	39.46	3.94	12.50	1.667	2.789	21.18
V_4W_1	29.79	10.43	69.90	0.506	0.572	21.01
V_4W_2	33.24	8.32	43.98	1.235	1.457	18.82
V_4W_3	33.74	6.06	24.54	1.422	1.717	16.38
V_4W_4	32.88	5.53	21.30	1.357	1.823	19.13
CD at 5%	4.43	1.34	9.68	0.0571	0.125	3.78
CV (%)	8.52	9.08	28.24	4.87	6.23	8.10

dSm^{-1}). Relatively, higher uptake and accumulation of sodium content in the leaf tissues could be directly or indirectly responsible for growth suppression either by depressing the uptake of other anions such as nitrate or by direct osmotic effects of high local concentration particularly on the leaf margin. There is more striking effect of sodium salts on potassium salts, which drastically decreased in tissues with increasing the salinity levels. It may be due to competitive phenomenon of sodium salt on potassium to reduce the uptake in plant roots (Creda *et al*., 2). In salt stress condition, the role of potassium is well documented where sodium and potassium may exchange during the salt uptake (Fox and Guerinot, 5). It was also supported by Srivastav *et al.* (13), and El Defan *et al.* (4). The interaction effect was found significant and lowest Na content (0.506%) was noted with treatment combination V_4W_1 followed by V_1W_1. The sodium and potassium ratio was increased with increasing salinity level. It might be due to the level of sodium content increased with increasing salinity level and so decreased the potassium level.

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