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Response of mango (*Mangifera indica*) genotypes to graded levels of salt stress*

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Among the several soil environmental conditions which can limit successful production or even survival of fruit bearing species is the salinity. The differences in salt tolerance among the plant species and varieties are of great importance for soil salinity management. Gupta *et al.* (2003) reported that salinity adversely affected the growth of mango (*Mangifera indica* L.) trees. The ability of mango trees to tolerate salinity varies among different genotypes and cultivars. In India, mango is a very important fruit crop share 50 % of the total world mango production and can be considered as backbone of fruit industry. This fruit crop is widely grown in arid and semi arid region. The soils of these areas suffered a serious set back due to various problems in which soil salinity is considered to be the most important hindrance. With the increasing population and continuous pressure on agricultural land, it has now become necessary to find out practical solution for the effective harnessing of salt affected soils for stepping up the production. For tackling problem of soil salinity it would be appropriate to develop tolerant rootstocks instead of going for soil reclamation. Salt tolerance was reported in *Mangifera indica* rootstocks, viz '13–1' and 'Turpentine' (Schmutz 1998), 'Gomera-1' (Zuao-Duran *et al.* 2004) and 'Dudhia Langra', 'Guruwari', 'Hybrid 15/1', 'Kurtha Kolumban' and 'Nariyal' (Nigam *et al.* 2002). Genetic diversity in mango appears to be wide enough to select rootstocks having salt tolerance (Whiley and Schaffer 1997). Keeping above in view an experiment was conducted to find out salt tolerant genotype(s) in mango.

Mango seedlings were grown from seeds in earthen pots of 30cm size lined with polythene and filled with 5 kg soil. Irrigation was given using tap water having salt concentration of 0.25 dS/m. There were 4×5 factorial arrangement of treatments with 4 genotypes ('Kurukkan', 'Olour', 'Kerala 1' and 'Kerala 2') and levels of salinity, viz 1.29 dS/m (exchangeable sodium percentage 13.2, *p*H 8.11), 2.15 dS/m (exchangeable sodium percentage 13.8, *p*H 8.20), 4.33 ds/m (exchangeable sodium percentage 14.6, *p*H 8.36) and 6.33 dS/m (ESP 15.2, *p*H 8.45) developed by combination of NaCl, Na_2CO_3 and K_2SO_4 salts to get the ratio of Cl^-: CO_3^{2-} : SO_4^{2-} in 2:1:1. As these anions are dominantly found in most of the natural saline soils of the country. The soil was sandy loam (Typic Haplustep) with $pH_{1:2}$ 7.35, electrical conductivity (E $C_{1:2}$) 0.30 dS/m, cation exchange capacity. 10.65 cmol/kg and organic carbon 0.43%. The electrical conductivity (E $C_{1:2}$) of the soil (0.30 dS/m) was taken as control. The experiments were conducted at experimental farm of Fruits and Horticultural Technology, IARI, New Delhi in 2003–04 with 3 genotypes and in 2004–05 with one more genotype ('Olour'). To get desired quantity of salts for 5 kg soil, a calibration curve was developed with stock solution of a combination of different salts by using NaCl (400 me Cl^-/litre), Na_2CO_3 (200 me CO_3^{2-}/litre) and K_2SO_4 (200 me SO_4^{2-}/litre). This stock solution was then added in 10 g of soil of known electrical conductivity (0.30 dS/m) in different quantities (0.5 ml to 6 ml) and then distilled water was added to get 1:2 soil : solution ratio for recording electrical conductivity of the samples after equilibration. A calibration curve was prepared (Fig 1) and amount of salt required for 5 kg soil was calculated for different salinity levels from the calibration curve. Computed amount of salts was dissolved in distilled water and required quantity was poured into the pots. The electrical conductivity of the soil was tested at regular interval and final salinity level was recorded (0.56, 1.29, 2.15, 4.23 and 6.32 dS/m) at the time of termination of the experiment.

Salt treatment was started after 90 days of germination and before new flush emergence so that the development of new flushes was under saline conditions. Measurement of vegetative parameters and injury symptoms were recorded at 15 days intervals. Plants were uprooted after 90 days of salinization and washed in tap water to remove soil from the roots and then in distilled water. After recording final growth data and fresh weight of shoot and roots, the plants partitioned in roots, stem and leaves. They were dried at 60 ± 1°C until constant weight and dry weight of roots and shoots were recorded. Chlorophyll contents of 'Olour' and 'Kurukkan'

*Short note

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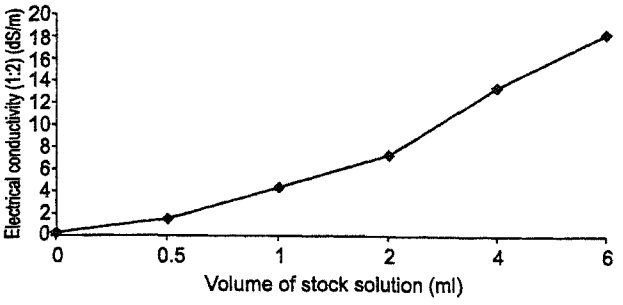

Fig 1 Calibration curve for the development of soil salinity of desired level

was estimated using the method given by Hiscox and Israelstom (1979).

Irrespective of genotypes the survival of seedlings decreased with the increasing levels of salinity. It was observed that at 6.32 dS/m salinity level seedlings of all the genotypes could not survive. Maximum number of plants survived (99.13 %) in 'Olour' where no salinity treatment was applied (Control). However 'Kerala 1' and 'Kerala 2' could not survive beyond 1.29 dS/m salinity (Table 1). This may due to the higher salinity levels induces osmotic stress caused by lowering the availability of external water, specific ion toxicity effects caused by metabolic process in the cell and nutritional imbalance caused by salts toxicity effect (Yassin 2004). Mango genotypes also differed with respect to the vegetative growth in terms of plant height, number of defoliated leaves, root length and root diameter due to salt toxicity. It was evident that excess of salts resulted in significant reduction in growth of all genotypes. The maximum height was recorded in control in all genotypes and a decreasing trend was observed as salinity levels increased . The minimum height of 'Olour' and 'Kurukkan' was recorded at 4.23 dS/m salinity. Similarly per cent reduction in height was also pronounced with the increasing salinity. Maximum reduction was found in 'Kerala 2' (22.08%) and minimum in 'Kurukkan' (4.78 %) at 1.29 dS/m. Whereas, at 4.23 dS/m salinity level reduction in plant height was recorded the highest in 'Olour' (24.65%) compared to 'Kurukkan'. The reduction in growth may be due toxic effect of salt leads to disturb the growth of plants and due to leaf injury, nutrition imbalance and reduction in the uptake of major nutrients. The reduction in growth was also reported due to salinity in mango by several workers (Gupta *et al.* 2003 and Morsy 2003). Leaf defoliation was more pronounced due to salinization. Maximum number of leaves was noted in all genotypes in control and minimum leaves were recorded at higher level of salinity. Maximum defoliation (22.08 %) was recorded in 'Kerala 2' and minimum in 'Kurukkan' (6.11%) at 1.29 dS/m. However 'Kurukkan' had maximum leaf defoliation at 4.23 dS/m salinity level (24.96 %). Similar findings were also reported by Ahmed and Ahmed (1997).

Table 1 Periodical survival of different polyembryonic mango genotypes at different soil salinity levels

Soil salinity levels	Survival (%)			
	15 DAS	30 DAS	60 DAS	90 DAS
	'Kerala 1'			
1.29dS/m	100.00	82.85	73.58	73.53
2.15dS/m	100.00	37.50	3.45	0.00
4.23ds/m	84.63	18.16	0.00	0.00
6.32dS/m	2.14	0.00	0.00	0.00
Control (0.56 dS/m)	100.00	98.45	98.45	98.45
	'Kerala 2'			
1.29dS/m	100.00	100.00	77.62	77.67
2.15dS/m	100.00	31.16	0.00	0.00
4.23ds/m	75.35	14.17	0.00	0.00
6.32dS/m	3.89	0.00	0.00	0.00
Control (0.56 dS/m)	100.00	100.00	97.35	97.35
	'Kurukkan'			
1.29dS/m	100.00	100.00	97.50	97.50
2.15dS/m	100.00	97.53	95.43	93.37
4.23ds/m	100.00	92.46	92.46	90.65
6.32dS/m	38.35	0.00	0.00	0.00
Control (0.56 dS/m)	100.00	100.00	96.43	96.43
	'Olour'			
1.29dS/m	100.00	100.00	97.37	98.37
2.15dS/m	100.00	97.50	88.45	85.83
4.23ds/m	100.00	93.16	83.14	80.60
6.32dS/m	16.18	0.00	0.00	0.00
Control (0.56 dS/m)	100.00	99.13	99.13	99.13

*DAS, Days after salinization

The growth of the roots was also influenced by the salinity stress. Root length decreases as salinity increased and maximum reduction in root length was found in 'Kurukkan' (53.29%) at 4.23 dS/m. While at 1.29 dS/m 'Olour' had minimum reduction in root length (8.70%). Dagar *et al.* (2005) also noticed root reduction in ornamental and medicinal periwinkle (*Catharanthus roseus* G. Don). Plant diameter and root diameter were also significantly influenced by salinity levels (Table 2). A reverse trend was observed in thickness of stem of both above cultivars and maximum plant diameter was recorded in untreated plants of both the cultivars. The minimum was found at higher level of salinity. However both cultivars behaved differently with respect to root diameter. 'Kurukkan' showed pattern similar to plant diameter, whereas 'Olour' root diameter was increased up to 2.15 dS/m thereafter it started declining as salinity levels increased beyond 2.15 dS/m. Fresh and dry weight of shoot and roots also varied at different salinity levels. Minimum fresh weight of shoot and root was found at higher level of salinity in all genotypes. Similar trend was also noticed in dry weight of root and shoot.

Table 2 Growth and chlorophyll content of two polyembryonic mango cultivars affected by salinity levels

Soil salinity level	Plant diameter (mm)	Root diameter (mm)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)
			'Kurukkan'		
1.29dS/m	6.30	6.60	0.12	0.055	0.148
2.15dS/m	6.03	6.40	0.092	0.051	0.129
4.23ds/m	4.50	4.56	0.042	0.058	0.141
Control (0.56 dS/m)	8.10	10.30	0.115	0.110	0.264
			'Olour'		
1.29dS/m	6.20	6.60	0.108	0.060	0.139
2.15dS/m	5.40	7.23	0.104	0.060	0.137
4.23ds/m	5.26	5.70	0.064	0.046	0.101
Control (0.56 dS/m)	6.23	6.23	0.108	0.139	0.165
CD (*P*=0.05)	0.72	1.14	0.009	0.008	0.013
CD (*P*=0.01)	1.00	1.57	0.012	0.011	0.018

Chlorophyll content of leaves, which is a vital component for photosynthetic activities in plant, was also influenced significantly with salinization (Table 2). Chlorophyll a, b and total chlorophyll decreased in both the cultivars as salinity increased. 'Kurukkan' (0.206 mg/g) and 'Olour' (0.108 mg/g) had maximum chlorophyll a in control plants and lowest 0.042 mg/g and 0.064 mg/g was found at 4.23 dS/m. Similarly total chlorophyll content was also found to be the highest in control plants and lowest at higher level of salinity (4.23 dS/m). The differential response noticed in these genotypes under varied salinity levels is clear indication of better tolerance observed in 'Olour' in response to assimilatory system (chlorophyll content).

It is also emphasized from the data that reduction in chlorophyll b are of prime importance which give a better clue for its specific role in increasing tolerance to salinity conditions. So relative reduction in chlorophyll may be utilized as indicator of down regulation of photosynthetic system in general. Above findings suggest that 'Kurukkan' and 'Olour' were found salt tolerant and they may be tested for their ability to translocate salts to the scion of commercial mango cultivars.

SUMMARY

Seedlings of 4 polyembryonic mango (*Mangifera indica* L.) genotypes were grown in earthen pots of 30 cm lined 1:2 with polythene under polythene tent. Different soil $EC_{1:2}$ levels ((0.30 dS/m (control) to 6.32dS/m) were maintained through application of NaCl : Na_2CO_3 : K_2SO_4 in 2:1:1 ratio. There was drastic difference in survival of mango genotypes in different salinity levels. 'Kurukkan' and 'Olour' seem to be more tolerant than 'Kerala 1' and 'Kerala 2'. They could survive up to 4.23 dS/m while 'Kerala 1' and 'Kerala 2' could not survive beyond 1.29 dS/m salinity levels. Growth rate was reduced in all genotypes as salinity level increased, however 'Kerala 1' and 'Kerala 2' were severely affected. There was significant difference ($P < 0.05$) in chlorophyll content at different salinity levels. Chlorophyll a, b and total chlorophyll contents decreased sharply in all genotypes with increasing soil salinity.

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