Annals of Arid Zone 38(2): 181-184, 1999

Growth Performance and Leaf Nutrient Status of Aonla (*Emblica officinalis* Gaertn) Cultivars in Saline and Sodic Soils

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Abstract: An experiment was conducted to evaluate the performance of aonla cultivars, viz., Banarasi, Francis, Krishna and Kanchan in artificially developed saline and sodic soils. Data recorded on plant survival, growth and leaf nutrient status revealed 100% plant survival in Francis and Kanchan in both saline and sodic soils. Growth of aonla cultivars, viz., Francis and Kanchan, was significantly better than that in Banarasi and Krishna. Total nitrogen, phosphorus and potassium status in the leaves of all aonla cultivars decreased significantly both in saline and sodic soils. Calcium and magnesium contents were reduced in response to sodicity, whereas salinity caused marked increase in the status of these two nutrients in all the aonla cultivars. Leaf sodium accumulation was in toxic quantities in response to both salinity and sodicity (alkalinity). Leaf injury symptoms were more conspicuous in Banarasi and Krishna than in Francis and Kanchan.

Key words: *Emblica officinalis*, aonla, salinity, sodicity.

Salinity and sodicity are the major problems in arid and semi-arid regions of our country. In the recent past, it was realized world-wide that more emphasis should be laid on the growing of salt tolerant hardy crops, rather than reclaiming such soils which is, in fact, a long term and expensive process. Considering the nutritional and medicinal importance of aonla fruits and hardy nature of tree, aonla seems to be a potential fruit crop in the years to come, especially for the proper utilization of degraded lands in hot arid and semi-arid regions of our country. There are reports that aonla tree has medium salt tolerance (Pathak, 1989) and its cultivar, Chakaiya, can be grown successfully upto 9.2 dS m^{-1} ECe in saline soils and upto 34.0 ESP in sodic soils (Dikshit, 1987). Since information on the varietal differences in respect of salinity and sodicity tolerance of aonla cultivars is meagre, the present experiment was taken up to evaluate four aonla cultivars, viz., Banarasi, Francis, Krishna and Kanchan, in terms of plant growth and leaf nutrient status in artificially developed saline and sodic soils.

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Materials and Methods

The experiment was conducted in 30 cm earthen pots. Glass wool and pebbles were kept on drainage hole at the bottom, and the pots were lined with polythene sheets to avoid leaching of salts. Chloride dominated salinity (ECe 10.3 dS m^{-1}) was maintained by incorporation of salt solution containing calcium chloride, magnesium chloride, sodium chloride and sodium sulphate into the normal soil. Sodium bicarbonate solution was used for maintaining the sodicity level (34.25 ESP). A control

Table 1. Effect of salt stress on growth attributes of aonla plants at 240-day stage

Cultivars	Normal soil	Saline soil	Sodic soil	Mean	Normal soil	Saline soil	Sodic soil	Mean
	Plant height (cm)				**Plant spread (cm)**			
Francis	133.00	101.20	124.50	119.56	49.00	37.50	40.50	42.33
Kanchan	140.00	111.50	115.00	122.16	44.50	41.00	39.05	41.52
Krishna	130.50	89.60	106.00	108.70	43.00	32.00	37.00	37.33
Banarasi	129.20	80.75	86.10	98.68	40.40	28.00	32.75	33.71
Mean	133.17	95.75	107.90		44.22	34.62	37.32	
	Stem diameter (cm)				**No. of branchlets/plant**			
Francis	1.69	1.44	1.59	1.57	157.75	136.50	144.25	147.16
Kanchan	1.74	1.57	1.52	1.61	142.00	125.25	121.25	136.16
Krishna	1.58	1.21	1.40	1.39	150.50	85.00	124.25	119.91
Banarasi	1.54	1.09	1.15	1.26	146.00	74.00	82.00	100.66
Mean	1.63	1.32	1.41		149.06	105.18	122.93	

CD (5%)	Cultivar	Soil	Cultivar x Soil
Plant height	1.26	1.09	2.19
Plant spread	0.93	0.81	1.62
Stem diameter	0.03	0.03	0.06
No. of branchlets	2.15	1.86	3.72

was maintained by saturating the normal soil with ordinary water having pH 7.55 and EC of 700 µmhos cm^{-1}. About 8-month-old uniform plants of aonla cultivars, Francis, Kanchan, Krishna and Banarasi, budded on seedling rootstocks, were planted in the pots. The plants were watered with tube well water (pH 7.55, EC 700 µmhos cm^{-1}) as per requirement. The observations were recorded on the plant survival, growth parameters, viz., plant height and spread, stem diameter and number of branches $plant^{-1}$, as well as on visual symptoms of salt injury. Leaf samples were taken in the month of September after stabilization of growth from the mid position of shoots and analyzed for various nutrients. The methods given by Peach and Tracey (1956), Richards (1954) and Chang and Bray (1951) were employed for analysis.

Results and Discussion

The survival in cultivars Francis and Kanchan, both in saline and sodic soils, was complete, while in Banarasi and Krishna it was less. Maximum plant height and stem diameter was recorded in Kanchan, while Francis attained maximum plant spread and number of branchlets $plant^{-1}$ (Table 1). In most of the cases, the differences between Kanchan and Francis were non-significant. On the other hand, Krishna and Banarasi showed significantly poor growth than Francis and Kanchan in saline and sodic soil. A comparative growth performance of aonla varieties was clearly expressed by the interaction between cultivars and soil types.

The nitrogen, phosphorus and potassium contents in the leaves of all aonla

Table 2. Effect of salt stress on leaf nutrient status of aonla leaves

Cultivars	Normal soil	Saline soil	Sodic soil	Mean	Normal soil	Saline soil	Sodic soil	Mean
	Nitrogen (%)				**Phosphorus (%)**			
Francis	2.63	2.34	2.52	2.49	0.158	0.120	0.126	0.134
Kanchan	2.54	2.47	2.40	2.47	0.152	0.123	0.126	0.133
Krishna	2.50	1.88	2.08	2.15	0.145	0.108	0.111	0.121
Banarasi	2.45	1.85	1.92	2.07	0.149	0.096	0.098	0.114
Mean	2.53	2.13	2.23		0.151	0.111	0.115	
	Potassium (%)				**Calcium (%)**			
Francis	0.900	0.808	0.825	0.844	1.366	1.422	1.259	1.347
Kanchan	0.880	0.838	0.820	0.845	1.344	1.403	1.240	1.329
Krishna	0.897	0.780	0.751	0.809	1.348	1.445	1.054	1.282
Banarasi	0.865	0.701	0.690	0.752	1.357	1.509	1.044	1.303
Mean	0.885	0.782	0.772		1.352	1.444	1.149	
	Magnesium (%)				**Sodium (%)**			
Francis	0.479	0.520	0.418	0.472	0.162	0.238	0.210	0.203
Kanchan	0.485	0.495	0.416	0.465	0.153	0.195	0.235	0.194
Krishna	0.489	0.534	0.410	0.477	0.160	0.248	0.278	0.228
Banarasi	0.480	0.560	0.370	0.470	0.159	0.281	0.315	0.252
Mean	0.483	0.527	0.403		0.158	0.240	0.259	

CD (5%)	**Cultivar**	**Soil**	**Cultivar x Soil**
Nitrogen	0.020	0.020	0.030
Phosphorus	0.003	0.002	0.008
Potassium	0.017	0.015	0.031
Calcium	0.023	0.020	0.040
Magnesium	0.007	0.007	0.012
Sodium	0.006	0.005	0.010

cultivars decreased significantly both in saline and sodic soils (Table 2). Calcium and magnesium contents were reduced in response to sodicity, while under salinity these increased in all the aonla cultivars. Leaf sodium accumulation was observed in toxic quantities in both saline and sodic soils. Leaf injury symptoms were more conspicuous in the cultivars Banarasi and Krishna. In saline soil, the injury symptoms comprised tip and marginal burning which progressed towards the base of leaves. Severely affected leaves abscised, leaving the stem naked. In sodic soil, symptoms were first observed on older leaves and gradually progressed inwards or towards the base. Reduced growth and nutrient imbalances in response to salinity and sodicity were recorded in mango (Thakur *et al.*, 1982), pomegranate (Patil and Patil, 1982), jamun (Patil and Patil, 1983) and macadamia seedlings (Hue and McCall, 1989).

It may be inferred that aonla cultivars, viz., Francis and Kanchan, can be grown successfully with 100% survival and satisfactory plant growth in saline soil upto 10.3 dS m^{-1} ECe, and in sodic soil upto 34.25 ESP. The cultivar Banarasi, proved to be the most susceptible of the cultivars tested in the experiment. The growth performance of Krishna was relatively better than that in Banarasi but, was significantly poor than that in Francis and Kanchan.

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