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Physiological studies and nutrient analysis on the suitability of *Clerodendrum inermi*, *Leucophyllum frutescens* and *Acalypha hispida* shrubs for use in landscaping under salinity conditions

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Abstract

The present study pertains to the effect of salt stress on three ornamental shrubs of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida* and their suitability for salinity condition. Ten saline treatments were taken *viz*., 6, 12, 18, 24, 30, 36, 42, 48, 54 dS/m and 0.04 dS/m (Control). The treatments were imposed by irrigating the plants with desired amount of NaCl dissolved in irrigation water. Plants were watered on alternate days (1 litre plant^{-1}) to simulated salinity conditions as seen near coastal belt. The observations were recorded on physiological parameters and nutrient analysis (K, Na), *Clerodendrum* and *Leucophyllum* were tolerant to salinity. *Leucophyllum* and *Clerodendrum* experienced a strong reduction in growth and a delay in flowering but no toxicity symptoms or mortality was recorded. These species were found to be moderate NaCl accumulators. *Acalypha* was sensitive to salinity, as 50% of the plants exhibited mortality and the surviving ones experienced a heavy reduction of growth and increased accumulation of NaCl in the leaves. Physiological parameters of relative water content (RWC) and membrane stability index which were found to decrease with increase in salt concentrations. *Clerodendrum* registered higher total chlorophyll content (SPAD value 56.73), membrane stability index (49.9 %) and *Leucophyllum* registered higher relative water content (70.13 %) at higher level of salt concentrations (54 dSm^{-1}). At higher salt levels, the percentage of nutrient contents were recorded as the K^+ concentration was found to be decreased with increasing levels of salt concentration. In the present investigation, *Leucophyllum frutescens* and *Acalypha hispida* were recorded as higher K^+ content (1.05 and 1.02% respectively) in the leaf at higher salt levels followed by *Clerodendrum inerme* (0.94%).

Keywords: salinity, physiological parameters, RWC, membrane stability index

Introduction

Among the commercial ornamental plants, *Clerodendrum inerme* (Verbenaceae) is a much branched, straggling shrub, 1-2 m tall. The plant is tough to sustain periodic trimming well, and hence, is commonly used as a hedge plant in India. It grows well on the beach, tolerating all the salty water sprays. Within India, it is found throughout, particularly near coastal regions. *Acalypha hispida*, the Chenille plant is a flowering shrub which belongs to the family Euphorbiaceae. Acalypha is the fourth largest genus of the Euphorbiaceae family, and contains many plants native to Hawaii and Oceania. The plant is dioecious, and therefore there are distinct male and female members of the species. The female plant bears pistillate flowers which range in colour from purple to bright red, and grow in clusters along catkins. This feature is the primary reason the plant bears the nickname “red-hot cat tail”. The pistillates will grow all year long as long as the temperatures are favourable. *Leucophyllum frutescens* is an evergreen shrub in the figwort family, Scrophulariaceae, native to the state of Texas in the south western United States and northern Mexico. Hence, it is popularly called as ‘Texas Sage’, commonly used for edge in warmer and drier areas.

Salinity is one of the major environmental factors limiting plant growth and productivity. It is estimated that about one-third of world’s cultivated land is affected by salinity (Kaya *et al*., 2003) [12]. Worldwide, more than 800 million hectares of land are salt affected and tolerance to this salinity differs greatly among plant species (Munns and Tester, 2008) [5]. In India alone, about 30 million hectares of coastal land is lying barren and uncultivable because of soil affected by salinity. Salt stress in soil or water is one of the major stresses especially in arid and semi-arid regions and can severely limit plant growth and productivity (Allakhverdier *et al*., 2000). It is a common environmental problem and an important factor limiting crop production, since it is a combined result of the complex interactions among different Physiological processes (Singh and Chatrath, 2001; Munns and Tester, 2008) [26, 5].

Of late, one of the major factors in the salt tolerance is believed to be the existence of succulence. Halophytes survive salt concentration equal to or greater than that of seawater and possess physiological mechanisms that maintain lower water potential inside the cell than that in the soil (Munns and Termaat, 1986) [8]. In saline environment, controlling the salt concentration of the aerial plant parts by restriction of entry through the roots (is there any role of caspacian layer in roots) and limiting transport to the shoots is an important mechanism allowing plants to survive and grow under salinity (Colmer *et al.*, 2005) [6]. The main effect of salinity on glycophytes is reduced growth (Munns and Termaat, 1986) [8] and this reduction has been used in many studies as a measure of resistance to saline conditions (Sanchez-Blanco *et al.*, 1991) [22]. In most arid and semiarid areas, salinity is accentuated by competition for high quality water among agriculture, industry and landscape users which has promoted the use of alternative water sources for irrigation. Thus marginal quality water, somewhat saline, will become important in these areas (Chartzoulakis *et al*., 2002) [5] and could be used for the irrigation of ornamental plants (Carter *et al*., 2005) [3]. However, the use of low quality water for irrigation affects plants in different ways, depending on the degree of salt tolerance of the species and even within a given species (Sanchez-Blanco *et al*., 2003) [23].

Hence, the objective of this study was physiologically assessing the growth pattern of three popular ornamental shrubs (*Leucophyllum frutescence*, *Acalypha hispida* and *Clerodendrum inerme*) and also to estimate the percentage of nutrient contents (K, Na) of the respective shrubs under different salt concentration levels.

Material and Methods

The experiment was conducted at the Botanic Gardens, Department of Floriculture and Landscaping, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2015-2016.

Soil characteristics

The media used for growing was pure river sand which was filled in the plot to a depth of 30 cm from the growth level and. The media was analyzed for physical and chemical properties and the results are presented in Table. 1.

Table 1: Physical and Chemical properties of the media (River sand)

S. No	Parameters	Value
1	Organic carbon	0.56%
2	pH	8.61
3	EC	0.06 dS m^{-1}
4	Available N	76 kg ha^{-1}
5	Available P(Olsen's)	9.9 kg ha^{-1}
6	Available K	204 kg ha^{-1}
7	Available Zn	0.72 ppm
8	Available Cu	1.79 ppm
9	Available Fe	0.54 ppm
10	Available Mn	2.41 ppm
11	Available S	28 ppm
12	Extractable Mg	69.5 ppm
13	Extractable Ca	85.9 ppm

Water composition

The experimental field was irrigated using potable water during the initial period of plant establishment. The properties of the irrigation water were used are given in Table. 2

Table 2: Compostion of Salts and Residual ions from the irrigated water

S. no	Parameters	Value
1.	pH	6.26
2.	EC	0.04 dS/m
3.	Ca	0.64 meq/L
4.	Mg	0.55 meq/L
5.	Na	0.03 meq/L
6.	K	0.02 meq/L
7.	HCO_3	0.80 meq/L
8.	Cl	1.60 meq/L
9.	SAR	0.04
10.	Adjusted SAR	0.04
Salt Species (meq/L)		
1.	Calcium bicarbonate	0.64
2.	Magnesium bicarbonate	0.16
3.	Magnesium chloride	0.39
4.	Sodium chloride	0.03
5.	Potassium chloride	0.02
Residualions (meq/L)		
1.	Chloride	1.16

List of plant species used for the screening study

The plant species involved in the study and their source is furnished below.

Common name	Botanical name	Source
Glory bower	*Clerodendrum inerme*	Botanic Gardens, TNAU
Purple sage	*Leucophyllum frutescens*	Botanic Gardens, TNAU
Red-hot cat tail	*Acalypha hispida*	Botanic Gardens, TNAU

The selected plantspecies were screened for tolerance to various levels of salinity stress, based on the observations carried out on growth, morphological, physiological, and biochemical parameters.

Statistical design

Design: Factorial Completely Randomized Design (FCRD)

S. No	Factor	Species / levels in factor	
1	Factor 1 -Plant species	P_1 -*Clerodendrum inerme*	
		P_2 - *Leucophyllum frutescens*	
		P_3 - *Acalypha hispida*	
2	Factor 2 - Salinity Levels	S_1- 6 dS m^{-1}	S_6- 36 dS m^{-1}
		S_2 - 12 dS m^{-1}	S_7 - 42dS m^{-1}
		S_3- 18 dS m^{-1}	S_8- 48 dS m^{-1}
		S_4 - 24 dS m^{-1}	S_9 - 54 dS m^{-1}
		S_5 - 30 dS m^{-1}	S_{10} – 0.04 dS m^{-1} (Control)

Duration of the study: 90 days
Number of replications: 2

Planting and study period

The cuttings were planted during August, 2015 in earthen pots of 40 x 30 cm size, provided with drainage holes at the bottom. The pots were filled with 5 kg soil containing mixture of sand, soil and FYM in the ratio of 1:2:1. The plants were maintained at optimal conditions by watering, weeding, manuring and plant protection sprays and were allowed to grow until they attained three to four fully mature leaves (90 days). The salinity stress treatments as indicated below were imposed when the plants attained three months of age so as to evaluate the influence of salt stress.

Imposition of salt stress

The stress treatments were imposed by irrigating with the NaCl dissolved water. Plants were watered at alternate days (1 litre $plant^{-1}$) with NaCl dissolved water to provide respective concentration of EC (6, 12, 18, 24, 30, 36, 42, 48, 54 dS/m and 0.04 dS/m (Control) after measuring the moisture content of the soil. For control, set of plants was maintained adjacent to the each of the treatment. The control (T_{10}) plant were irrigated with water (EC = 0.04 dS/m and 6.8 pH) without any added NaCl. The treatment details are as follows.

Treatment details

Treatment Notation	EC (dS/m)
T_1	6
T_2	12
T_3	18
T_4	24
T_5	30
T_6	36
T_7	42
T_8	48
T_9	54
Control- T_{10}	0.04(Siruvani water)*

*Siruvani water is from Siruvani river in Coimbatore, which is a major source of drinking water.

Result and Discussion

Physiological assessment and percentage of nutrient contents on the growth pattern of three popular ornamental shrubs (*Leucophyllum frutescence*, *Acalypha hispida* and *Clerodendrum inerme*) under different salt concentration levels. Relative water content is an appropriate method to assess the plant water status, which in turn can be used to screen the plants for stress tolerance. Among the plant species, maximum mean RWC (76.46%) was observed in, *Clerodendrum inerme* followed by *Leucophyllum frutescens* (75.17%) and the minimum mean RWC (50.31%) was observed in *Acalypha hispida*. RWC in plants is mainly dependant on the water status of the rhizosphere (Saeed *et al*., 2014) [21]. In the present study, it could be observed that salinity levels resulted in drastic reductions in RWC, especially at higher concentrations of NaCl. The plant species exhibited differential rates of reduction in RWC in the ten salt stress levels tested. Among the treatments, the control registered highest RWC. The RWC was less in *Acalypha hispida* in the treatments T_6 - T_9 compared to *Clerodendrum inerme* and *Leucophyllum frutescence* which maintained higher level of RWC, whereas the susceptible registered least RWC (<65.3%). Among different salt concentrations, the maximum mean RWC (91.53 %) was observed in T_{10} control (0.04 dS/m) and the minimum mean relative water content (45.40 %) was observed in T_8 (48 dS/m) treatment. The decrease in RWC may be to be due to high salt concentration of the external solution, which causes osmotic stress and dehydration at the cellular level. In addition, lowering the water potential in the protoplast alters the integrity of photosynthetic apparatus via photo-phosphoryliosis and electron transfer. The findings of this experiment were in accordance to the observations reported by Neocleous and Vasilakakis (2007) [16]; Hajiboland *et al*., 2014 [10] and Khayyat *et al*., 2014 [13]. The result of the experiment revealed that the relative water content exhibited significant difference in the interactions of plant species and salt levels. The maximum relative water content was recorded in P_3T_{10} (95.06%), followed by P_1T_{10} (93.10%) and P_2T_{10} (86.44%). The minimum relative water content was recorded in P_1T_9 (65.98%), followed by P_1T_8 (66.72%) (Table.3)

A significant reduction in membrane stability index (MSI) in leaf due to imposed salt stress was observed in all the plants. Among interaction, the maximum MSI (73.79%) was observed in *Clerodendrum inerme*, in control, and the minimum MSI (43.0 %) was observed in *Leucophyllum frutescens.* with T_9 (54 dS/m) treatment. Osmotic stress can be triggered by decreased water potential at low or moderate salinity levels, which in turn causes cell dehydration (Ondrasek *et al*., 2009) [18]. This influences water and nutrient uptake and stomatal closure (partially or fully) leading to reduction in transpiration and CO_2 accumulation, reduction in cell growth and development, decreased leaf area and chlorophyll content, accelerated defoliation and senescence, ultimately resulting mortality of plant (Shannon and Grive, 1999) [25]. (Table.4)

Table 3: Effect of salinity on relative water content (RWC) of *Clerodendrum inerme, Leucophyllum frutescens* and *Acalypha hispida*

Treatment	Relative water content (%)										
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**	**T_{10}**	**Mean**
P_1	87.93	80.34	76.58	74.34	70.34	68.35	68.00	66.72	65.98	93.10	75.17
P_2	83.87	80.67	78.43	76.12	73.68	72.67	71.65	70.89	70.13	86.44	76.46
P_3	87.59	84.19	81.02	78.58	76.23	0.10	0.10	0.10	0.10	95.06	50.31
Mean	86.46	81.73	78.68	76.35	73.42	47.04	46.58	45.90	45.40	91.53	67.31
Interactions	P				T				P X T		
SE(d)	0.73				1.34				2.33		
CD (P=0.05)	1.50**				2.75**				4.76**		

Plant species	Salt concentrations (dS/m)				
P_1- *Clerodendrum inerme*	T_1-6	T_4 - 24	T_7 - 42	T_{10} - 0.04 (control)	**Highly significant
$_2$ - *Leucophyllum frutescens*	T_2 - 12	T_5 - 30	T_8 - 48		
P_3- *Acalypha hispida*	T_3 - 18	T_6 - 36	T_9 - 54		

***Significant at 5% level

Table 4: Effect of salt stress on Membrane Stability Index (%) of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida*

Treatments	Membrane Stability Index (%)										
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	Mean
P_1	72.42	68.41	65.76	64.02	60.76	57.32	54.76	52.91	49.95	73.79	62.01
P_2	67.32	64.31	61.87	57.08	54.69	50.82	48.04	45.97	43	70.32	56.34
P_3	66.31	63.59	60.17	58.14	55.01	52.44	50.1	49.03	48.09	67.47	57.04
Mean	68.68	65.44	62.6	59.75	56.82	53.53	50.97	49.3	47.01	70.53	58.46
Interactions	P				T				P X T		
SE(d)	0.59				1.08				1.87		
CD (P=0.05)	1.21**				2.21**				3.83**		

Plant species	Salt concentrations (dS/m)				
P_1 - Clerodendrum inerme	T_1-6	T_4 - 24	T_7 - 42	T_{10} - 0.04 (Control)	**Highly significant
P_2 - Leucophyllum frutescens	T_2 - 12	T_5 - 30	T_8 - 48		
P_3 - *Acalypha hispida*	T_3 - 18	T_6 - 36	T_9 - 54		

***Significant at 5% level**

Total chlorophyll index was recorded among the plant species, maximum mean chlorophyll index (56.04) was observed in *Leucophyllum* followed by *Clerodendrum* (55.19). The minimum mean chlorophyll index (21.10) was observed in *Acalypha hispida*. In different salt concentrations, the maximum mean chlorophyll index (56.32) was observed in control (0.04dS/m) and the minimum mean chlorophyll index (34.95) was observed in treatments T_8 (48dS/m). SPAD value has a strong positive and significant correlation with chlorophyll a, b, total chlorophyll and RWC. The trend of SPAD values observed in the study in three plant species followed the trend of chlorophyll and indicated that *Clerodendrum inerme*, and *Leucophyllum frutescens* were less affected at T_{10} (control) (0.04dS/m) (62.74), Higher reductions were observed at higher salt concentrations. Significant differences were observed in the interaction effect between plant species and salt levels. The maximum chlorophyll index was recorded in P_1T_{10} (62.74), followed by P_1T_1 (61.22), P_2T_1 (59.34), P_1T_2 (57.93) which are all on par with each other. The minimum chlorophyll index was recorded in P_3T_5 (26.16). Chlorophyll a concentration is usually reduced by salinity because of suppression of specific enzymes responsible for synthesis of photosynthetic pigments (Murkute *et al.*, 2006) [15] (Table.5).

Plate 1: Field view

Table 5: Effect of salinity on chlorophyll index (SPAD value) of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida*

Treatments	Chlorophyll index (SPAD value)										
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	Mean
P_1	61.22	57.93	57.39	56.1	53.37	52.72	51.03	49.95	49.51	62.74	55.19
P_2	59.34	57.26	57.24	56.43	54.35	52.68	53.73	54.9	56.73	57.8	56.04
P_3	40.35	36.35	32.91	26.48	26.16	0.1	0.1	0.1	0.1	48.42	21.10
Mean	53.63	50.51	49.18	46.33	44.62	35.16	34.95	34.98	35.44	56.32	44.11
Interactions	P				T				P X T		
SE(d)	0.277				0.506				0.877		
CD (P=0.05)	0.566**				1.034**				1.792**		

Plant species	Salt concentrations (dS/m)				
P_1- *Clerodendrum inerme*	T_1-6	T_4 - 24	T_7 - 42	T_{10} - 0.04	**Highly significant
P_2 - *Leucophyllum frutescens*	T_2 - 12	T_5 - 30	T_8 - 48		
P_3- *Acalypha hispida*	T_3 - 18	T_6 - 36	T_9 - 54		

***Significant at 5% level**

Nutrient analysis

In the present investigation, *Clerodendrum inerme* and *Acalypha hispida* recorded lower increase in potassium content (0.94% and 1.02% respectively) in the leaf under T_9 treatment and least decreasein *Leucophyllum frutescens* (1.05 % respectively) in the leaf under T_9 treatment. The effect of salt stress on leaf potassium content was differed among the plants were among the plants, maximum mean leaf potassium content (1.68 %) was observed in *Acalypha hispida*, whereas the minimum mean leaf potassium content (1.60 %) was observed in *Clerodendrum inerme*. Among the treatments, the maximum mean leaf potassium content (2.07%) was observed in control, the minimum mean leaf potassium content (1.00 %) was observed in treatments T_9. A significant reduction in leaf potassium content in leaf due to imposed salt stress in all the plants. Among interaction, the maximum mean leaf potassium (2.08) was observed in *Leucophyllum frutescens* in control, and the minimum mean leaf potassium content (1.01%) was observed in *Clerodendrum inerme* with T_8 (48 dS/m) (Table.6) the reason might be due to increased K uptake implicates in reducing the toxic ions entering into the plants from the soil solution, and such exclusion mechanism can be an added advantage to the tolerant variety. It is well documented that a greater degree of salt tolerance in plants is associated with a more efficient system for the selective uptake of K^+ over Na^+ (Noble and Rogers, 1992; Ashraf and O'Leary, 1996). In conditions, where the salt concentration is higher in soil, the plant gets more sodium (Na+) ions than it requires and thereby blocks the intake of potassium (K+) and calcium (Ca+) ions into the leaves (Turhan and Seniz, 2010) [27].

Based on the above findings, it can be concluded that under high salinity stress, the three plant species exhibited lower levels of Na^+ concentrations. Moreover, salt stress increased the Na^+ concentrations concomitant with a decrease in K^+ accumulations in comparatively salt sensitive plants. Thus, in addition to the toxic effects of high concentrations of Na^+ in plant tissue, the salinity also induced changes in mineral nutrition uptake and thereby. Furthermore, tolerant nature of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida* plant species may be due to uptake and further accumulation of Na^+. Among the plants, maximum mean leaf sodium content (0.55 %) was observed in plant *Clerodendrum inerme,* whereas the minimum mean leaf sodium content (0.53 %) was observed in *Acalypha hispida* and *Leucophyllum frutescens.* Among the treatments, the maximum mean leaf sodium content (0.69%) was observed in treatment T_9 and the minimum mean leaf sodium content (0.41 %) was observed in. control. Sodium ion concentrations in leaf tissues increased with increasing salinity in all plants. The maximum leaf sodium content (0.70%) was recorded in *Leucophyllum frutescens*, and the minimum leaf sodium content (0.39%) was recorded in *Acalypha hispida* (Table.7). The findings of this experiment was in accordance with results of study conducted by Pandey *et al*. (2014) [19] in olive, Hajiboland *et al*. (2014) [10] in pistachio seedlings and Schmutz and Ludders (1999) [23] in mango. These results are similar to those of Dudeck *et al*. (1983) [7] who reported a reduction in K but increment in Na levels in Bermuda grass cultivars. Qian *et al.* (2000) [20] noted a reduction in K and an increase in shoot Na concentration of Zoysia grass cultivars at 42.5dS m^{-1}. When NaCl level increased to 15 dS m^{-1}, the plants exposed to saline stress might have also encountered difficulty in obtaining required nutrients due to modified selectivity of nutrients. The requirement for increased nutrient concentration in the medium of NaCl stressed plants is due to competition by Na with cations (K, Ca, and Mg) (Yeo and Flowers, 1984) [28]. Accumulation of cytoplasmic Na^+ can interfere with the catalytic role of K^+ related to many metabolic processes including conversion of sugars to starch biosynthesis (Chartzoulakis *et al.*, 2006) [4]. When the ion concentration in the cytoplasm generally ranges from 100 to 200 mM, the cytoplasm and shows a strong affinity for K over Na, Mg over Ca and phosphate over chloride or nitrate. Under saline conditions, large quantities of inorganic salts (mainly NaCl) absorbed into the leaves are accumulated mainly in the vacuole (Heslop-Harrison and Reger, 1986) [11] reported that a halophyte such as *Suaeda martitima* showed optimum growth under high salt concentration. Most of the plants die under salinity due to accumulation of Na^+ or Cl^- which may limit the flow of carbon compound to meristem and growing zones in leaves, which leads to death of plants.

Table 6: Effect of salinity on Potassium content (%) of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida*

Treatments	**Potassium content (%)**										
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**	**T_{10}**	**Mean**
P_1	2.06	1.92	1.82	1.75	1.55	1.48	1.37	1.01	0.94	2.07	1.60
P_2	2.07	1.98	1.76	1.71	1.68	1.63	1.54	1.20	1.05	2.08	1.67
P_3	2.03	2.04	1.77	1.76	1.69	1.69	1.59	1.20	1.02	2.05	1.68
Mean	2.05	1.98	1.78	1.74	1.64	1.60	1.50	1.14	1.00	2.07	1.65
Interactions	P				T				P X T		
SE(d)	0.01				0.01				0.02		
CD (P=0.05)	0.02				0.03				0.05**		
Plant species		Salt concentrations (dS/m)									
P_1- *Clerodendrum inerme*		T_1-6	T_4 - 24	T_7 - 42	T_{10} - 0.04 (Control)						
P_2 - *Leucophyllum frutescens*		T_2 - 12	T_5 - 30	T_8 - 48							
P_3- *Acalypha hispida*		T_3 - 18	T_6 - 36	T_9 - 54							

*****Significant at 5% level

Table 7: Effect of salinity on Sodium content (%) of *Clerodendrum inerme*, *Leucophyllum frutescens* and *Acalypha hispida*

Treatments	**Sodium content (%)**										
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**	**T_8**	**T_9**	**T_{10}**	**Mean**
P_1	0.45	0.49	0.49	0.51	0.52	0.57	0.63	0.67	0.69	0.44	0.55
P_2	0.42	0.45	0.48	0.53	0.55	0.57	0.57	0.65	0.70	0.40	0.53
P_3	0.43	0.43	0.47	0.53	0.55	0.58	0.57	0.63	0.69	0.39	0.53
Mean	0.43	0.46	0.48	0.52	0.54	0.57	0.59	0.65	0.69	0.41	0.54
Interactions	P				T				P X T		
SE(d)	0.002				0.005				0.009		
CD (P=0.05)	0.006				0.010				0.018**		
Plant species		Salt concentrations (dS/m)									
P_1 - Clerodendrum inerme		T_1-6	T_4 - 24	T_7 - 42	T_{10} - 0.04 (Control)		**Highly significant				
P_2 - Leucophyllum frutescens		T_2 - 12	T_5 - 30	T_8 - 48							
P_3 - Acalypha hispida		T_3 - 18	T_6 - 36	T_9 - 54							

*Significant at 5% level

Conclusion

The present work is done with objectives to analyze the physiological parameters and percentage of nutrient contents (K, Na) in three poular shrubs of *Leucophyllum frutescens, Clerodendrum inerme*, *Acalypha hispida* for use in landscaping under saline conditions as proven by earlier authors. Based on the overall performance for physiological parameters and percentage of nutrient contents, it can be concluded that salinity tolerance level and of plant species for saline conditions is in order of *Leucophyllum frutescens >Clerodendrum inerme> Acalypha hispida*. Hence, *Leucophyllum frutescens* and *Clerodendrum inerme*; may be recommended for saline situations such as beach resorts, coastal areas, etc.

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