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BIOCHEMICAL AND CHEMICAL ANALYSIS OF BEET ROOT (*BETA VULGARIS* L.) UNDER SALINITY STRESS

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Abstract: A Pot Experiment was laid out in completely randomized design having six levels of salinity treatments of irrigation water viz., control (EC 1.48 dS m^{-1}), EC 2 dS m^{-1}, EC 4 dS m^{-1}, EC 6 dS m^{-1}, EC 8 dS m^{-1} and EC 10 dS m^{-1}. The biochemical and chemical parameters of beet root leaves were studied under different salinity levels of irrigation. The biochemical (total carbohydrate, total soluble protein, total fat content, nitrate content and crude fiber) and chemical (Na, K, Ca and Mg) parameters of leaves of beet root were affected significantly under different treatment of salinity levels of irrigation water. The total carbohydrate, total fat content and crude fiber were maximum under control (EC 1.48 dS m^{-1}), while total soluble protein was observed in EC 4dS m-1 and total fat content with EC 6 dS m-1. The maximum Na content was observed in leaves irrigated with water of EC 10 dS m-1. While maximum K, Ca and Mg were reported in control (EC 1.48 dS m-1). The biochemical parameters and chemical contents like K, Ca and Mg of beet root leaves tended to decrease with increase in irrigation water salinity while content of Na in leaves showed increasing pattern with increase in level of salinity.
Keywords: Biochemical, Chemical content, Salinity, Carbohydrates.

Introduction

Fodder Beet root (*Beta vulgaris* L.) belongs to the family *Amaranthaceae*. The beet (*Beta vulgaris* L.) is a biennial plant grown for it fleshy, swollen root. The size, shape and colour of the root are extremely variable and depend on the variety. They are mainly an energy feed due to their high content of water soluble carbohydrates (55 to 70 % DM, mostly sucrose). There is a positive relationship between DM content and sugar content and intermediate fodder-sugar types contain both more sugar (up to 80 %) and DM (up to 20 %) than types used only for fodder. In many parts of the world, a considerable area of irrigated arable land has been facing a serious problem of salinization. Estimates have shown that around 6% of the global land area suffers from salinization due to natural causes or irrigation, posing a major constrain on agricultural production. It is estimated that irrigation related salinization leads to the abandonment of 107 hectares of agricultural land annually (Frans *et al.*, 2001). Out of the total arable and potentially arable land, about 25% is situated in arid and semi-arid

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climatic zones. Szabolcz (1991) has reported that 10% of the world's land surface is estimated to be affected by salinity and solicits.

Gujarat contributing a high coastal area, cultivation of high water consuming crop like sugarcane is becoming more difficult than earlier. Similarly, the area under salt affected soils in canal command as well as coastal belt has increased sizably due to the cultivation of sugarcane in south Gujarat. Soil salinity in south Gujarat varies from slight to strong salinity class. In Bharuch district soil salinity varies from slight to moderate and severe in coastal belt. While in Narmada, Tapi and Dangs districts soil salinity is moderate. The soil salinity in Surat, Navsari and Valsad districts belong to slight to strong salinity class. Hence it will be beneficial to study the effect of different salinity of irrigation water on beet root in saline condition so that it can be recommended for the salt affected area. Hence the present investigation was proposed.

Material and methods

A pot experiment was conducted with fodder beet at the poly house environment in the Department of Soil Science and Agricultural Chemistry, N. M. College of Agricultural, Navsari Agricultural University, Navasri during 2014. For this experiment, 48 earthen pots of 20 kg capacity having average diameter of 25 cm and 60 cm height were used. For irrigation in the pots, six grades of saline water having different EC (TW, 2 dS m^{-1}, 4 dS m^{-1}, 6 dS m^{-1}, 8 dS m^{-1} and 10 dS m^{-1}) were prepared (using sea water and diluted with TW) in this experiment. The chemical composition of irrigation water used is given in table 1. The earthen pots were irrigated as and when required with uniform quantity as per treatments. The sea water was collected from nearest seacoast *i.e.* Dandi sea shore, which is having EC 55 dS/m and was diluted with TW as per the treatments. The design of the layout was completely randomized with four repetitions. Six treatments comprised of five levels of irrigation water along with control as tap water (*(EC 1.48 dS m-1)*). The pot were filled with 20 kg experiment soils after mixing with FYM (10g pot^{-1}) and N, P_2O_5, and K_2O (120:60:60 kg ha^{-1}) (Jai, 2012). Four seeds per pot were placed by dibbling 2 to 3 cm deep in the soil and irrigated immediately as per treatments. The various biochemical and chemical parameters of beet root leaves at harvest were analyzed under different salinity levels of irrigation *Viz.* total carbohydrate content, total soluble protein, total fat content, nitrate content, crude fibre content, Sodium (Na), Potasium (K), Calcium (Ca) and Magnesium (Mg). The experimental data were subjected to the statistical analysis by using analysis of variance technique as described by Panse and Sukhatme (1967).

Table 1: Chemical analysis of irrigation water used in the pot experiment

Particulars	TW	2 EC	4 EC	6 EC	8 EC	10 EC
pH	7.69	7.72	7.81	7.85	7.88	7.92
EC (dS m^{-1})	1.48	1.98	4.04	5.96	7.93	10.02
HCO_3 (me l^{-1})	7.86	8.97	12.2	12.92	14.58	21.75
CO_3 (me l^{-1})	Nil	Nil	Nil	Nil	Nil	Nil
Cl (me l^{-1})	4.92	7.32	20.4	35.52	45.88	50.25
SO_4 (me l^{-1})	1.69	3.21	6.95	10.93	17.65	25.15
Ca + Mg (me l^{-1})	9.03	10.76	14.33	15.67	19.57	28.54
Na (me l^{-1})	5.07	10.37	28.15	42.81	57.53	71.24
K (me l^{-1})	0.25	0.38	0.49	0.74	1.07	1.89
RSC (me l^{-1})	-1.17	-1.79	-2.13	-2.75	-4.99	-6.79
SAR	2.39	4.47	10.52	15.29	18.39	18.86

Results

The biochemical (total carbohydrate, total soluble protein, total fat content, nitrate content and crude fiber) and chemical (Na, K, Ca and Mg) parameters of leaves of beet root were affected significantly under different treatment of salinity levels of irrigation water.

The maximum total carbohydrate of beet root leaves at harvesting (6.29 %) was recorded in control (T_1) while, the minimum total carbohydrate of beet root was noted in EC 10 dS m^{-1} (T_6) at harvesting (5.03 %). Maximum total soluble protein of beet root leaves at harvesting (0.168 mg/g) were recorded in control (T_1), which was at par with EC 2 dSm^{-1}. Maximum total fat content of beet root leaves (0.550 %) was recorded under control (T_1), while, the minimum total fat content of fodder beet was noted in EC 10 dS m^{-1} (T_6) at harvesting (0.346 %). The maximum nitrate content of beet at harvesting (5999.00 ppm) was recorded under salinity level EC 10 dS m^{-1} (T_6) while, the minimum nitrate content of beet was noted in control (T_1) at harvesting (3746.50 ppm). The maximum crude fiber content of beet root at harvesting (3.85 %) was noted with control, EC 2 dS m^{-1} and EC 4 dS m^{-1} (T_1, T_2 and T_3). While, the minimum crude fiber content of beet root was noted in EC 10 dS m^{-1} (T_6) at harvesting (1.68 %). The maximum total carbohydrate, total soluble protein, total fat content were recorded in control and nitrate content EC 10 dS m^{-1} respectively. Isla *et al.* (1998) reported that production of protein and nucleotide is inhibited by salinity ultimately resulting in decreased plant mass due to inhibition in cell division and cell enlargement. NaCl treatment lowered the protein content in leaves of *Dioscorea rotundata* plant. Similar results have been reported in sorghum (Azooz *et al*., 2004). Protein degradation in a saline environment has been attributed to decreased protein synthesis, accelerated proteolysis, decreased availability of amino acids, and denaturation of enzymes involved in protein synthesis (Levitt, 1980).

The maximum sodium content of beet root leaves at harvesting (0.556 %) was found in EC 10 dS m^{-1} (T_6) while, the minimum sodium content of beet root was noted in control (T_1) at harvesting i.e. 0.373 %. The higher potassium content of beet root at harvesting (1.250 %) was recorded under control (T_1) while, the minimum potassium content of fodder beet was noted in EC 10 dS m^{-1} (T_6) at harvesting (0.547 %). The maximum calcium content of fodder beet at harvesting (2.988 %) was observed with control (T_1) while, the minimum calcium content of fodder beet was noted in EC 10 dS m^{-1} (T_6) at harvesting (2.617 %). The maximum magnesium content of fodder beet at harvesting (0.258 %) was reported in control (T_1). The minimum magnesium content of fodder beet was noted in EC 10 dS m^{-1} (T_6) at harvesting (0.231 %).

An increase in Na content in root and leaves and decrease in Ca and K content in leaves also seemed to be one of the reasons for reduction in biomass yield of fodder beet. This is further substantiated by the presence of significantly negative correlation between Na content in leaves and roots with fresh weight of leaves and root. Contrary to this, K and Ca content in leaves of root showed significantly positive association with fresh weight of leaves and root. An increase in Na concentration in leaves could also be attributed to the use of diluted sea water used in present study, the analysis of which indicated the preponderance of Na and Cl. The finding of present study is in close agreement with those earlier reported by Eisa and ali (2003).

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Table 2: Effect of salinity stress on biochemical parameters of beet root leaves at harvesting

Treatments	Biochemical parameters			
	Total carbohydrate %	Total soluble protein (mg/g)	Total fat content %	Nitrate content (ppm)
T_1 – Control	6.29	0.168	0.550	3746.50
T_2 - EC 2 dS m^{-1}	5.87	0.165	0.508	4375.00
T_3 - EC 4 dS m^{-1}	5.38	0.154	0.488	4820.50
T_4 - EC 6 dS m^{-1}	5.24	0.137	0.445	5005.75
T_5 - EC 8 dS m^{-1}	5.22	0.108	0.415	5461.87
T_6 - EC 10 dS m^{-1}	5.03	0.096	0.346	5999.00
S.Em±	0.0069	0.0020	0.0052	0.4886
C.D. at 5%	0.020	0.0060	0.015	1.4022
C.V. %	0.35	1.059	3.23	0.03

Table 3: Effect of salinity stress on chemical parameters of beet root leaves at harvesting

Treatments	Chemical parameters			
	Sodium content (%)	Potassium content (%)	Calcium content (%)	Magnesium content (%)
T_1 – Control	0.313	1.250	2.988	0.258
T_2 - EC 2 dS m^{-1}	0.361	0.963	2.882	0.254
T_3 - EC 4 dS m^{-1}	0.390	0.796	2.871	0.248
T_4 - EC 6 dS m^{-1}	0.454	0.695	2.777	0.245
T_5 - EC 8 dS m^{-1}	0.488	0.595	2.721	0.235
T_6 - EC 10 dS m^{-1}	0.556	0.547	2.617	0.231
S.Em±	0.0004	0.0040	0.0059	0.0004
C.D. at 5%	0.0010	0.011	0.017	0.0012
C.V. %	0.23	1.41	0.60	0.49