

Effect of Salinity on Growth and Yield in Berseem (*Trifolium alexandrinum* L.)

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Abstract

Two cultivars of berseem (salt tolerant JHB-146 and salt sensitive JB-5) were exposed to salinity in field. Various growth parameters such as length, weight (fresh and dry) of root and shoot, dry weight of leaflets decreased with increasing salinity levels. In contrast, more inhibitory effect was shown by JB-5. Dry mass of plant increased at 4 and 8 dS/m but progressively decreased at 12 to 24 dS/m. The results on forage yield indicated an increase at 4 and 8 dS/m and a significant decrease was recorded at 12 to 24 dS/m. It was increased with successive cuttings.

Key words : Berseem, Salinity, Salts, Growth, Yield.

Soil salinity affects various plant physiological processes depending on salt type and concentrations, plant genotype, growth stage and environmental conditions (1). The alteration on plant growth in saline environment may be due to either unspecific osmotic effects or specific ion toxicity. Saline soils which are common in arid regions, adversely affect the growth and yield of most agricultural plants. The obvious effects of salinity include reduction in size, suppression of growth and poor yield. The salt concentration in plant root zone is usually higher than that of irrigation water. All types of soils have mixture of soluble salts, some of which are essential for growth but higher concentration of salts retard growth. The problem of soil salinity is severe in the coastal area and also in the irrigation commands of Gujarat. Prevalence of highly saline ground water and high water table aggravate salinity hazards in most part of the Bhal area of Gujarat state. Identification of economically important halophytes and salt tolerant plants and also the feasibility of using saline water for irrigation would form an important management strategy for bringing saline soil under production. Though, studies on evolving technology for domesticating an economic halophyte, *Salvadora persica* (2) and some salt tolerant forage grasses (3) have been studied, information on growth and forage production of forage crops under saline water

irrigation when grown on saline soils is scanty. In present research work, we report growth and biomass yield of berseem on saline soil under saline water irrigation and feasibility of their introduction in biosaline agricultural programs.

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Methods

The experiment was conducted during 2005 session to study the effect of salinity on growth and yield of berseem (*Trifolium alexandrinum* L. cv JHB-146 and *Trifolium alexandrinum* L. cv JB-5) at village Talampur (Moradabad). Common agronomic practices were followed for preparation of field and seed sowing. The agricultural field was irrigated with water before ploughing and left for six days, then harrowed and ploughed by tractor. The experimental soil samples were collected randomly in triplicate and sent to Department of Soil Science, G. B. P. University of

Table 1. Effect of saline water irrigation on growth parameters in variety JHB-146 of berseem at different growth stages.

Salinity (dS/m)	Stem length (cm)	Stem fresh weight (g)	Stem dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Number of leaflets	Leaf-dry weight (g)	Total dry matter (g)
30 DAS								
Control	12.52	0.91	0.34	0.31	0.044	10.1	0.41	0.79
4	NS	0.94	0.45	NS	NS	NS	0.46	0.97
8	14.62	0.98	0.51	NS	NS	11.9	0.47	1.01
12	11.68	NS	0.29	NS	NS	NS	0.38	0.72
16	10.0	0.61	0.24	NS	0.024	6.7	0.36	0.63
20	07.0	0.53	0.12	0.19	0.019	6.7	0.35	0.52
24	05.0	0.51	0.10	0.15	0.015	6.7	0.33	0.45
60 DAS								
Control	29.5	1.24	0.57	0.54	0.13	14.0	0.57	1.31
4	30.9	1.29	0.74	NS	NS	16.0	NS	1.39
8	32.4	1.44	0.73	NS	NS	17.0	0.63	1.49
12	26.9	1.19	NS	NS	0.11	NS	0.41	1.04
16	25.5	1.14	0.52	0.41	0.10	NS	0.38	1.02
20	23.8	1.09	0.51	0.37	0.09	12.0	0.38	0.98
24	22.9	0.94	0.48	0.31	0.08	12.0	0.34	0.92
90 DAS								
Control	45.5	10.4	3.5	0.84	0.29	16.1	0.58	4.41
4	45.9	11.1	4.8	NS	0.31	19.2	NS	5.93
8	55.9	11.4	5.4	NS	0.27	21.9	0.64	6.54
12	41.9	10.2	3.1	0.74	0.27	NS	0.42	3.81
16	37.0	8.4	2.6	0.69	0.22	13.9	0.34	3.21
20	34.0	7.5	2.1	0.67	0.18	13.0	0.39	2.68
24	33.0	6.6	1.0	0.57	0.16	11.0	0.37	1.64
120 DAS								
Control	79.8	21.9	11.4	2.21	0.64	54.0	1.00	13.2
4	87.0	25.2	14.5	NS	NS	64.0	1.04	16.3
8	90.6	26.1	15.4	NS	0.59	70.0	1.21	16.5
12	75.0	21.1	10.3	2.14	0.57	NS	0.96	11.1
16	70.1	19.9	9.4	2.12	0.57	52.0	0.76	8.8
20	60.1	19.4	9.0	2.11	0.53	50.1	0.57	7.5
24	50.0	17.1	8.1	1.97	0.50	46.1	0.52	5.4
150 DAS								
Control	110.2	31.2	16.4	3.29	1.27	78.0	1.59	28.9
4	115.2	37.1	19.1	NS	1.29	83.0	1.99	30.4
8	120.2	37.1	19.0	NS	NS	86.1	2.49	33.0
12	105.1	27.3	14.0	NS	1.25	72.1	1.49	27.8
16	100.0	24.1	11.4	3.19	1.19	68.1	1.39	23.6
20	95.0	22.2	11.0	3.19	1.17	54.0	1.38	22.4
24	91.0	20.0	10.0	2.81	1.15	48.1	1.29	19.6
180 DAS								
Control	129.5	24.6	13.1	4.28	2.61	135.1	0.55	23.1
4	NS	28.6	14.1	NS	NS	141.1	0.57	24.6
8	140.1	29.9	15.4	NS	2.57	147.8	0.65	26.0
12	119.1	22.9	12.1	4.21	2.57	129.0	NS	21.0
16	110.1	21.0	10.1	4.18	2.49	126.0	0.47	20.6
20	104.1	18.0	9.6	4.14	2.47	121.0	0.42	19.8
24	104.0	17.0	9.1	3.75	2.29	97.0	0.41	18.8
CD at 5%								
Salinity (S)	0.886	0.0291	0.0392	0.0751	0.0165	1.31	0.0065	0.0018
Duration (D)	0.820	0.0275	0.0365	0.0710	0.0135	1.20	0.0056	0.0017
S × D	2.150	0.0731	0.0271	0.0180	0.0285	4.00	0.0014	0.0097

Table 2. Effect of saline water irrigation on growth parameters in variety JB-5 of berseem at different growth stages.

Salinity (dS/m)	Stem length (cm)	Stem fresh weight (g)	Stem dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Number of leaflets	Leaflets dry weight (g)	Total dry matter (g)
30 DAS								
Control	12.9	0.73	0.33	0.30	0.042	9.1	0.37	0.76
4	NS	0.88	0.45	NS	NS	NS	0.41	0.091
8	14.2	0.93	0.47	NS	NS	11.0	0.45	0.95
12	11.1	0.63	0.28	NS	NS	NS	0.33	0.64
16	9.1	0.52	0.23	0.23	0.0023	NS	0.32	0.58
20	7.4	0.50	0.10	0.18	0.017	NS	0.31	0.44
24	4.5	0.37	0.08	0.14	0.012	6.0	0.27	0.36
60 DAS								
Control	28.2	1.00	0.57	0.51	0.12	14.0	0.54	1.19
4	NS	1.12	0.72	0.58	0.14	15.9	0.56	1.39
8	31.4	1.40	0.71	NS	NS	16.5	0.62	1.38
12	NS	1.05	NS	NS	0.10	NS	0.38	1.0
16	25.0	1.03	0.50	0.39	0.10	NS	0.34	0.96
20	23.0	0.96	0.48	0.35	0.07	11.0	0.33	0.91
24	22.0	0.79	0.47	0.28	0.05	10.0	0.29	0.81
90 DAS								
Control	45.0	9.5	3.5	0.83	0.28	15.0	0.55	3.74
4	51.0	10.0	4.8	NS	0.31	NS	0.58	5.95
8	52.0	11.0	4.9	NS	0.27	20.0	0.63	6.54
12	40.0	10.2	2.0	0.73	0.26	NS	0.40	2.80
16	39.0	6.5	1.8	0.67	0.21	13.0	0.39	2.58
20	37.0	5.6	1.4	0.65	0.17	12.0	0.36	2.49
24	36.0	4.70	0.8	0.52	0.15	10.0	0.33	1.37
120 DAS								
Control	79.0	21.2	10.3	2.20	0.63	58.0	1.0	12.1
4	86.1	24.2	13.3	NS	NS	62.0	NS	15.3
8	89.7	25.0	14.3	NS	0.58	70.0	1.02	16.0
12	73.0	19.8	9.4	2.13	0.55	NS	0.83	11.0
16	68.1	18.5	6.6	2.10	0.53	49.1	0.69	7.7
20	58.1	17.6	5.2	2.08	0.51	47.1	0.53	6.5
24	46.1	14.3	3.1	1.80	0.40	44.1	0.41	3.8
150 DAS								
Control	108.1	30.2	14.9	3.27	1.26	75.9	1.59	23.8
4	113.1	34.4	17.4	NS	NS	80.1	NS	29.8
8	118.0	35.1	17.9	NS	NS	84.1	2.29	31.0
12	103.2	26.3	13.1	NS	1.23	70.1	1.38	21.6
16	098.1	22.1	10.1	3.18	1.17	68.1	1.19	20.0
20	093.0	19.9	10.1	3.12	1.16	53.0	1.09	15.7
24	086.9	16.5	8.1	2.51	0.93	46.0	0.81	10.0
180 DAS								
Control	115.6	20.0	10.1	4.27	2.56	118.1	0.43	20.3
4	116.5	23.5	12.1	NS	NS	131.0	0.51	22.2
8	130.1	24.2	12.5	NS	NS	139.0	0.55	23.2
12	111.7	18.0	9.4	4.17	2.54	107.0	0.41	19.3
16	109.1	17.0	8.1	4.14	2.47	105.0	0.40	18.2
20	099.3	15.2	7.7	4.13	2.39	100.0	0.35	14.5
24	098.7	13.0	0.61	3.03	1.81	83.0	0.29	9.5
CD at 5%								
Salinity (S)	0.880	0.0182	0.0435	0.064	0.0170	1.53	0.67	0.0088
Duration (D)	0.731	0.0168	0.0372	0.067	0.0141	1.41	0.062	0.0082
S × D	0.593	0.0448	0.0308	0.016	0.0201	3.77	0.015	0.0021

Table 3. Effect of saline water irrigation on forage yield in variety JHB-146 of berseem at different growth stages.

Salinity (dS/m)	Fresh weight (kg/plot)	Dry weight (kg/plot)
40 DAS		
Control	0.65	0.38
4	0.77	0.42
8	0.81	0.45
12	0.56	0.36
16	0.55	0.34
20	0.52	0.31
24	0.51	0.32
80 DAS		
Control	0.76	0.43
4	0.86	0.46
8	0.85	0.48
12	0.75	0.42
16	0.68	0.40
20	0.65	0.39
24	0.63	0.38
120 DAS		
Control	0.85	0.50
4	0.94	0.52
8	1.09	0.56
12	0.83	0.48
16	0.75	0.45
20	0.72	0.43
24	0.67	0.41
145 DAS		
Control	0.92	0.55
4	1.29	0.69
8	1.59	0.81
12	0.89	0.47
16	0.82	0.41
20	0.78	0.39
24	0.68	0.34
CD at 5%		
Salinity (S)	0.0023	0.0015
Duration (D)	0.0022	0.0014
S × D	0.0016	0.0006

Agriculture and Technology, Pantnagar, U. S. Nagar (Uttarakhand) for physico-chemical analysis of soil. The plots of 1 × 1 m area of different salinities were prepared and separated from each other by polythene sheets of 0.2 mm thickness, up to a depth of 28 cm to stop leaching of salts between two adjacent plots. The experiment was laid out in randomized block de-

sign with three replicates. Saline solutions of 4, 8, 12, 16, 20 and 24 dS/m were prepared by mixing salts viz. NaCl, NaHCO₃, CaCl₂ and Na₂SO₄ in tube well water by standard method (4). Control sets were irrigated with tube well water, whose electrical conductivity was 0.514 dS/m. Before sowing, the seeds were surface sterilized with 0.1% HgCl₂ solution for one minute and thoroughly washed with distilled water to exclude the possibility of any kind of fungal infection. These seeds were sown in different plots at evening of 23 of October, 2005. Nearly, three gram seeds of each variety were sown in respective plot at equal distance. First irrigation was done at the next day of sowing by using 10 liter of saline solutions in each plot. At the same time, control sets were treated with tube well water. Second, third, fourth and fifth irrigations were done at 60, 90, 120 and 150 days after sowing (DAS). Plants were collected randomly and uprooted with intact nodules at 30 DAS. The observations were recorded on growth viz. shoot, root, number of leaflets and total dry matter. All observations have been mentioned on plant basis. Same observations were recorded at 60, 90, 120, 150 and 180 DAS. For determining forage yield, the plants were cut at 40, 80, 120 and 145 DAS. For dry weight, the plant materials were kept in hot air oven at 60 C for 48 hours. For the sake of convenience and accuracy, all the observations were taken in three replicates and each replicate carried three plants.

Results and Discussion

Salinity becomes a problem when enough salts accumulate in root zone which adversely affects plant growth. It suppresses growth and the suppression increases as the salt concentration increase until the plant dies. Tolerance to salinity varies among species. This has led to division of species into physiological groups, glycophytes that tolerate only low concentrations of salt and halophytes that tolerate relatively higher concentrations. The present findings on morpho-physiological characteristics as affected by saline water irrigations are presented in Tables 1 and 2 at different growth stages. The over all effects of salinity were reduction in growth, number of leaflets, weight of root, shoot and leaflets dry weight with increasing levels of salinity (4 to dS/m) in both the genotypes. The reductions were drastic

at 20 to 24 dS/m. The results indicated that plant height progressively and significantly increased with advancement of plant age. An increase was noticed up to 8 dS/m and then a continuous decrease was observed. These results are in accordance with earlier findings (5, 6). The results on fresh and dry weight of stem showed an increase up to 8 dS/m and then a continuous reduction was observed. Stunted growth with increasing salinity may be due to physiological scarcity of water in root zone and by limiting supply of essential metabolites caused by higher concentration of salts. A decline in root dry mass may be a disadvantage in terms of affecting a plants ability to seek nutrients in the soil and transport them to growing shoots. Shoot growth is a complex process and several factors other than root growth are involved. The fresh and dry weight of roots were severe affected with saline water irrigation at all growth stages. It was increased with advancement of plant age (30 to 180 DAS), but decreased with increasing levels of salinity up to 24 dS/m except 4 dS/m. This is due to concentrated salt surrounding the root membrane affecting the morphology of root of plants.

The present findings indicate that initiation of leaflets gradually and significantly increased with advancement of plant age but differentially affected under various saline irrigations. Number of leaflets emerged per plant was significantly enhanced at 4 to 8 dS/m but significantly decreased from 12 to 24 dS/m. The dry weight increased from 30 to 150 DAS but declined at 180 DAS. In general, a significant increase in dry weight was observed at 4 to 8 dS/m, whereas a significant reduction was observed from 12 to 24 dS/m at harvests. The process of stem growth is probably also affected by same forces that limit leaf growth during salt stress.

The reduction in total dry matter and forage yield at 12 to 24 dS/m corresponded with reduced number of leaflets and their fresh and dry weight. It is assumed that these saline treatments had inhibited photosynthetic area per plant. Drastic reductions in yield potential at 16 to 24 dS/m also coincided similarly with reduced number and weight of leaflets. Tables 1

and 2 indicate that though number of leaflets enhanced at 180 DAS compared to at 150 DAS. It might be due to reduced leaf area per plant as the fresh and dry weight of leaflets also significantly declined at 180 DAS. It is confirmed in berseem and sengi (7).

The present findings on forage yield at different durations (40, 80, 120 and 145 DAS) are recorded in Tables 3 and 4. The results indicate that forage yield gradually and significantly increased from 40 to 145 DAS in control and treated sets. The fresh and dry weight of yield per plot enhanced at 4 to 8 dS/m but declined at 12 to 24 dS/m. These results are confirmed by earlier reports (8, 9).

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