Annals of Arid Zone 31 (2) 115–118 1992

Ecophysiological Studies on Saltwort in the Indian Desert

Sher Mohammed and David N Sen
Ecology Laboratory, Botany Department, University of Jodhpur, Jodhpur–342 001 India

Abstract Saltwort is a halophyte growing naturally in the highly saline tracts of the Indian desert. This investigation was conducted to determine salt resistance, soil-plant relationships, metabolic process and survival of the saltwort (*Suaeda fruticosa* (L.) Forsk.) as influenced by salinity. This species exhibited higher sugar and protein contents in rainy season and higher chlorophyll under salt stress. Proline accumulation was higher in the winter followed by summer and lowest in the rainy season. All the elements *viz.*, Na, K, Ca and Cl studied in plant and soil did not follow a definite pattern.

Key words Ecophysiology, Saltwort, Indian desert, Salinity.

Suaeda fruticosa (L.) Forsk. (chenopodiaceae) commonly known as saltwort has the special ability to withstand extremely saline conditions (Fig. 1). Like other halophytic species it may also resort to certain physiological adaptations to overcome the adverse saline environment. Their tolerance to salinity is related to the intrinsic ability to maintain a high level of salt concentration within cells. Plants which grow in saline environments absorb ions from the growth medium in different proportions. Such a change in ion content and ionic composition of plant cells induces changes in the activity of certain metabolic systems (waisel 1972, Sen & Mohammed 1991).

The present study was thus designed to obtain a better understanding on the ecophysiology of *S. fruticosa* including salt resistance, soil-plant relationships, metabolic processes and their role in plant survival in a harsh saline environment in the Indian desert.

Materials and Methods

Plant and soil samples were collected during each month of 1985 to 1987 from the Pachpadra Salt Basin located at 26° 56'51" N and 72° 11' 06" E, 100 km West of Jodhpur town. The area is arid with 106. 0 ± 3.42 mm average annual rainfall largely received in monsoon (July–September).

Fresh leaf samples collected were analysed for free proline (Bates *et al.* 1973), chlorophyll (Arnon 1949) and osmotic potential (Janardhan *et al.* 1975). Oven dried, powdered leaf material was analysed for concentration of elements (acid digestion), sugars (Plummer 1971) and crude protein (Peach & Tracey 1955). Elements (Na, K, Ca) content in leaves and soil water extract (1:5) were determined by flame photometer, while Cl by titrametric procedures as described by Allen *et al.* (1976) and Piper (1950). The soil samples were collected from 0–20 cm depths.

The data analysed for analysis of variance as per Gomez and Gomez (1984).

Results and Discussion

The leaves of *S. fruticosa* showed comparatively higher values of Na, K, Ca and Cl in the months of January, July, April and November, respectively whereas in soil these were higher in April, except Ca (Table 1). Definite order of periodic variations was however not observed. The monthly variations in contents of all ions in leaves indicate a seasonal pattern of incoming and outgoing salts. The factors which might be responsible for inducing the changes are : age of leaf, growth rate, temperature, transpiration rate, electrolyte concentration of soil water and metric potential of soil water (Sharma *et al.* 1972). The uptake of Na and Cl by some halophytes is related to the external salt concentrations (Zhao *et al.* 1986), but *S. fruticosa* did not follow this pattern.

Table 1 *Monthly variations in mineral elements in soil and leaves of Suaeda fruticosa.*

Months	Leaf (mg g^{-1})				Soil (mg 100 g^{-1})			
	Na	K	Ca	Cl (%)	Na	K	Ca	Cl (%)
Jan.	414.1	43.1	4.7	15.0	937.5	47.5	93.8	2.3
Feb.	313.1	38.7	4.4	12.8	3031.0	67.5	117.5	2.6
March	293.8	45.0	4.4	16.6	4125.0	70.0	127.5	3.8
Apr.	350.5	41.5	7.4	17.2	4200.0	72.5	133.0	4.0
May	303.1	26.3	6.0	12.1	350.0	25.0	87.8	1.5
June	320.4	35.5	7.3	15.4	930.0	60.0	144.0	2.8
July	292.9	46.5	4.4	14.4	734.4	50.0	45.0	0.5
Aug.	158.1	26.6	1.6	12.5	484.3	7.9	18.0	0.3
Sep.	133.1	13.1	5.5	18.4	506.3	31.5	79.2	1.0
Oct.	115.0	10.3	6.3	18.8	938.0	26.0	103.0	0.6
Nov.	135.0	18.8	6.4	18.9	2625.0	71.0	124.0	3.2
Dec.	282.0	38.4	3.4	16.5	2800.0	75.0	131.8	1.4
CD at 5%	32.06	11.39	2.77	5.14	10.34	13.27	18.43	13.12

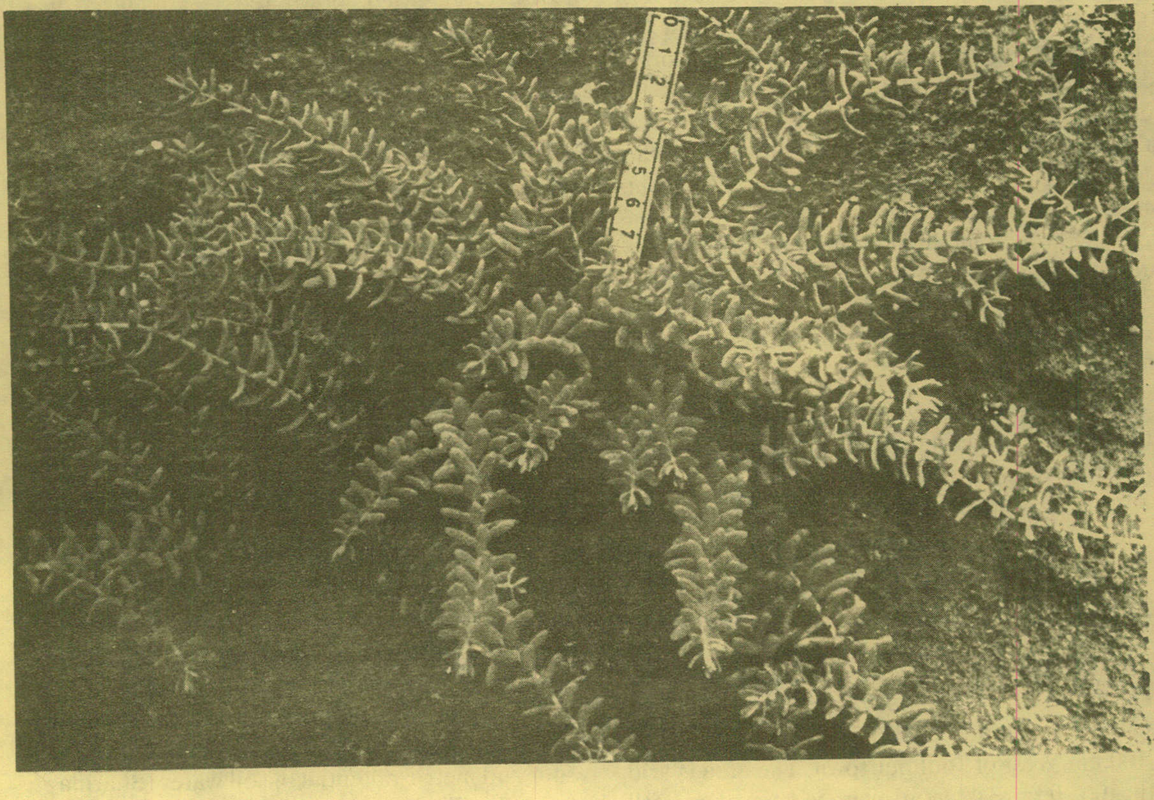

Fig. 1 Natural habit of S. fruticos.a

S. fruticosa showed higher sugar content during rainy season followed by winter and least in summer period (Table 2). The content decreased gradually from August to December but no definite trend was observed for other months. The maximum value of sugar content in *S. fruticosa* during rainy season may be due to low salinity as compared to summer and winter seasons. Timpa *et al.* (1986) observed that water stressed plants showed twice the amount of sugar content over the values determined for the irrigated plants in cotton.

The crude protein content in *S. fruticosa* was maximum in June when plant-soil water status was higher (Table 2). This may be due to low salinity by leaching processes or active plant growth. Doddema *et al.* (1986) observed decreased soluble protein under saline condition.

The water and salt stress on chlorophyll and most of the biochemical processes are adversely affected because of the water imbalances. But *S. fruticosa* exhibited higher chlorophyll during salt stress. The highest values of total chlorophyll (*a* & *b*) and of carotenoids were observed in December and minimum in September (Table 2). Lapin & Papov (1970) attributed a decrease in total chlorophyll to the destruction of chlorophyll *a* which is considered to be more sensitive than chlorophyll *b* under salt stress. But in the present study reverse trends were obtained, as chlorophyll *a* decreased with increasing moisture, while chlorophyll *b* decreased with salt stress.

Proline has been known to accumulate in the leaves of many plant species when subjected to low temperature, water stress, salt stress or even starvation (Chu *et al.* 1976,Mohammed & Sen 1990). *S. fruticosa* accumulated more proline during winter months followed by summer and least in rainy season. A low osmotic potential in cell sap was also noted during winter months and maximum in rainy months (Table 2). This may be due to the fact that during unfavourable period, soil-water could not be absorbed by plants because of low osmotic potential of the medium which created stress conditions in plant cells. Thus it appears that accumulation of proline acts as an intracellular osmotic adjustment in their cell sap and probably proline may be playing some role for tolerance of *S. fruticosa* under harsh saline conditions.

Thus it can be said that *S. fruticosa* is a well adapted plant under saline conditions and can be used for bioreclamation and utilization of salt affected lands.

Table 2 *Monthly variations in leaf chlorophyl, sugar, protein, proline and osmotic potential (OP) of Suaeda fruticosa.*

Months	Chlorophyl (mg g^{-1})			Sugar (mg g^{-1})	Crude protein (%)	Proline (μg g^{-1})	OP (-bars)
	Chl. *a*	Chl. *b*	Carotenoid				
Jan.	0.23	0.14	0.06	35.15	28.43	4.18	77.37
Feb.	0.41	0.14	0.17	34.86	25.00	11.93	87.15
Mar.	0.48	0.12	0.25	33.75	28.12	4.44	87.58
Apr.	0.39	0.10	0.20	30.45	22.52	5.75	89.50
May	0.34	0.03	0.20	18.75	29.06	7.02	66.37
Jun.	0.38	0.08	0.24	25.85	31.75	8.52	62.50
Jul.	0.33	0.08	0.13	39.12	14.81	7.52	59.69
Aug.	0.18	0.25	0.11	40.37	18.62	0.005	70.94
Sep.	0.11	0.03	0.05	28.64	10.93	1.41	79.08
Oct.	0.24	0.13	0.02	19.53	29.68	0.02	79.81
Nov.	0.26	0.08	0.09	14.46	14.06	6.76	76.83
Dec.	0.51	0.15	0.18	11.74	9.37	6.21	81.52
CD at 5%	0.57	0.38	0.53	5.96	7.33	7.98	4.88

Acknowledgement

Financial assistance received from Department of Environment, Govt. of India, New Delhi is gratefully acknowledged.

References

Allen SE, Grimshaw AM, Parkinson JA, Quarmby C & Roberts JD 1976 Chemical analysis. In : *Methoids in Plant Ecology* (Ed. SB Chapman), Blackwell Science Publicshers, Oxford, 412–466

Arnon DI 1949 Copper enzymes in isolated chloroplasts, polyphenol oxidase in *Beta vulgaris*. *Plant Physiology* **24** 1-15

Bates LS, Waldren RP & Teare ID 1973 Rapid determination of free proline for water stress studies. *Plant and Soil* **39** 205-207

Chu TM, Aspinall D & Paleg LG 1976 Stress metabolism VII. Salinity and proline accumulation in barley. *Australian Journal of Plant Physiology* **3** 219 –228

Doddema H, Saadeddin R & Manasneh A 1986 Effects of seasonal changes of soil salinity and soil nitrogen on the N-metabolism of the halophyte *Arthrochemum fruticosa* (L.) Moq. *Plant and Soil* **92** 279-293

Gomez, KA & Gomez AA 1984 *Statistical Procedures for Agricultural Research* (2nd ed.), John Wiley and Sons, New York, USA

Janardhan KV, Murthy ASP, Giriraj K & Panchaksharaih S 1975 A rapid method for determination of osmotic potential of plant cell sap. *Current Science* **44** 390-391

Lapin L & Papov AB 1970 Effect of sodium chloride on the photosynthetic apparatus of tomatoes. *Indian Journal of Plant Physiology* **13** 477-481

Mohammed S & Sen DN 1990 Environmental changes and proline content in some desert plants. *Journal of Arid Environment* **19** 241-243

Peach K and Tracey MV 1955 *Modern Methods of Plant Analysis*. Springer–Verlag, Berlin.

Piper CS 1950 *Soil and Plant Analysis*. Interscience Publishers Inc., New York.

Plummer DT 1971 *An Introduction to Practical Biochemistry*. Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Sen DN & Mohammed S 1991 Ecology and biology of halophytes in Indian arid zone. In : *Expanding Horizons in Botanical Research*, (Ed. T.N. Nag). Arihant Publishers, Jaipur, 87-99

Sharma ML, Tunny J & Tongway DJ 1972 Seasonal changes in sodium chloride concentration of saltbush (*Atriplex* spp.) leaves as related to soil and plant water potential. *Australian Journal of Agriculture Research* **23** 1007-1019

Timpa JD, Burke JJ, Quisenberry JE & Wendt CW 1986 Effect of water stress on the organic acid and carbohydrate composition of cotton plants. *Plant Physiology* **82** 724-728

Waisal Y 1972 *Biology of Halophytes* Academic Press New York

Zhao Ke fu, Liming Liang & Liu, Jia–Yao 1986. Reduction by GA3 of NaC1–induced inhibition of growth and development in *Suaeda ussuriensis*. *Australian Journal of Plant Physiology* **13** 547-552

(Received August 1991 Accepted February 1992)