Annals of Arid Zone 30(4) : 347-351, 1991

SALT BLADDERS IN *ATRIPLEX* SPP.

PRAMILA RAJPUT AND DAVID N. SEN

Laboratory of Plant Ecology, Department of Botany
University of Jodhpur, Jodhpur-342 001

ABSTRACT

Salt accumulation in bladder cells is the primary means of salt exclusion in *Atriplex* spp., before it reaches a toxic level in the cell sap. Comparative studies of salt bladders in *A. holocarpa* F. Muell. and *A. vesicaria* Heward ex. Benth. showed differences in the number of stalk cells and size of the bladders. Bladder structure in young leaves of both species is similar but the variations occur more in the older leaves.

INTRODUCTION

Salt accumulation in the cell or vacuole sap appears to be the primary means of osmotic regulation in the family Chenopodiaceae (Storey et al. 1977). In plants such as *Atriplex*, where such a system does exist, excess salts are exuded through vesiculated hairs to prevent salt accumulation from scaling toxic levels (Waisel 1972; Mozafar and Goodin 1970).

Several mechanisms reduce the salt content of active tissues of leaves: excretion, accumulation in bladder hairs, retranslocation to other organs and shedding of old leaves. The relative importance of each mechanism varies among the different species of halophytes, and their efficiency changes with the specific ecological conditions. These trichomes or salt bladders are considered as salt glands and they function as specialized organs for the removal of salts from the leaves. Salt-rich vesiculated hairs on *Atriplex* leaves has been reported to perform several xerophytic functions also (Wood 1925). Studies on morphology and anatomy of salt bladders are reported herein.

MATERIAL AND METHODS

Two exotic *Atriplex* species, selected for the present study on structure of salt bladders are: *A. vesicaria* Heward ex. Benth. (bladder salt bush) and *A. holocarpa* F. Muell. The plants were raised in experimental plots spaced at 1 x 1 m in Botanical Garden, University of Jodhpur, and irrigated with tap water (EC 1.12 dS m^{-1}) twice a week. Epidermal peelings of the fresh young and mature leaves were used for studying the structure of salt bladders. The pre calibrated research microscope was used to measure the size and number of bladders and epidermal cells of the peelings and ten peelings of each species of young leaves were used. The samples collected

from the tip portion were considered as young, while the fully expanded leaves from 7th-8th node as mature ones. Microphotographs of the leaf sections and surface views were taken under phase contrast and stereomicroscope, respectively.

RESULTS AND DISCUSSION

(a) **A. holocarpa :**

The surface views of the leaf peelings show that unicellular bladders (Fig. 1) were present on both the surfaces and also sparsely on stem. Thin stalks and large bladders (Figs. 2, 3) were found on young and mature leaves. The surface of the mature leaves was covered by matted debris. Stalk was mostly bicellular, but the bladder was unicellular. The shape and size of the bladder varied from spherical to elliptical (Table 1).

(b) **A. vesicaria :**

The unicellular bladders occured on the both leaf surfaces which run longitudinally along the leaf surfaces (Fig. 4). The size of the bladders here were larger as compared to *A. vesicaria* but the length of the stalk was more (39.87 μ) (Fig. 4). Stalks were very thin and unicellular (Table 1). When the concen tration of salts in bladders reaches a critical limit and or leaf ages, they burst, leaving a matted surface 'scurf' of salt crystals intermixed with the waxy wall material of 'spent' bladders, appearing as debris (Osmond et al. 1980) (Fig. 1).

The bladders were unique structures: the stalk cell was the only pathway through which salts pass in order to enter the bladder cell (and were therefore, specialised for ion transport as well as salinity tolerance). The salts were concentrated to a point that surpassed the saturation point of NaCl and must be unusually salt tolerant. The salt hairs are known to remove over 50% of the leaf ionic content against a concentration gradient (Osmond 1963). A stalk cell and plasmodesmata connect the vesicle and the epidermis (Goodin and Mozafar 1972). Plasmodesmata is the likely means of transport across the cell wall (West 1970). Salt glands serve as

Table 1. Characteristics of bladders in two species of *Atriplex*.

Species	Shape	No. of epidermal cells mm^{-2}	No. of bladder mm^{-2}	No. of stalk cells	Stalk cell		Bladder	
					Length (μ)	Breadth (μ)	Length (μ)	Breadth (μ)
A. holocarpa	Spherical	1056.6 ±110.7	180.4 ±12.9	1-2	15.1 ±1.4	3 4 ±0.7	41.2 ±2.2	41.2 ±2.2
	Elliptical			1-2	16.0 ±6·8	3.4 ±0.6	76.4 ±15.2	35,7 ±2.2
A. vesicaria	Spherical	410 5 —19.5	1753.0 ±8.8	1	39.8 ±1.3	2.7 ±0.0	67.4 ± 1.3	49.5 ±6.0

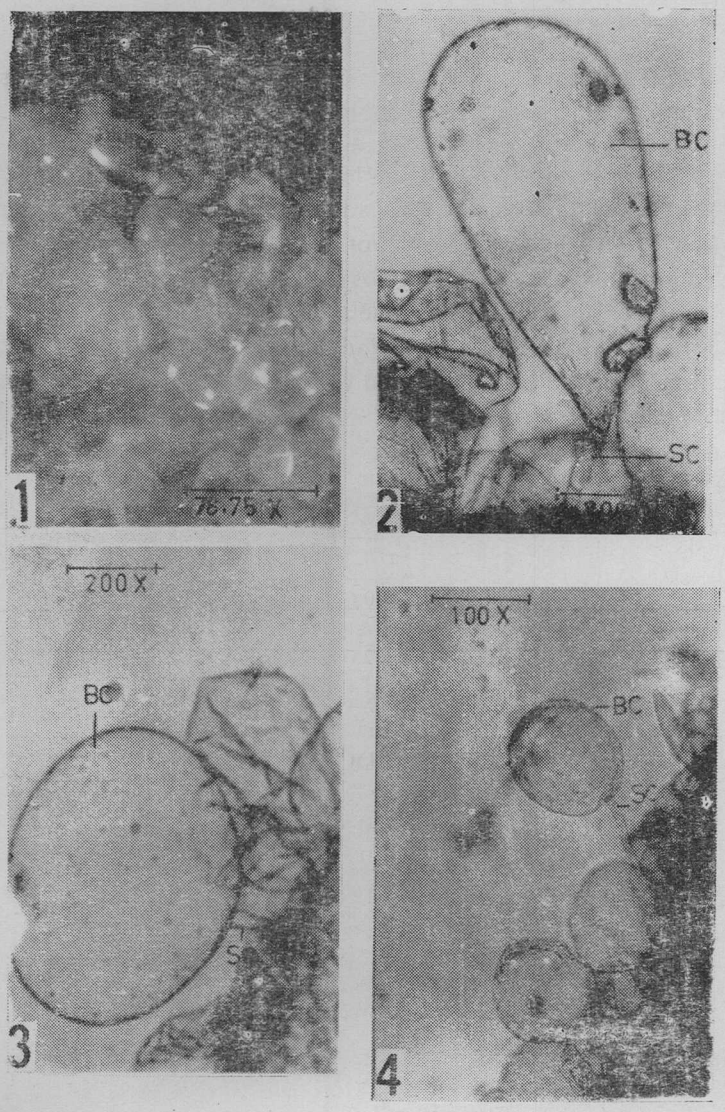

Fig. 1. Surface view of a young leaf of *A. halocarpa* with intact salt glands (bladders) (x 78.75) SM.

Fig. 2 & 3. Transaction of the young leaf of *A. holocarpa* with bladder cells (BC) and thin delicate bicelled stalk cell (SC) (x 200 mm).

Fig. 4. Transaction of the young leaf of *A. vesicaria* with bladder cells (BC) and stalk cell (SC) (x 100).

salt reservoirs to which excess salts are pumped for storage and later released to the exterior (Mozafar and Goodin 1970).

Generally the vesicle is described as stalked (1 to 4 stalk cell) bearing a swollen bladder cell, 80 to 200 m in diameter (Osmond et al. 1980).

The size of the bladder varies, and may have direct relation between the salt tolerance capacity of the plant. There was not much difference between the bladders on both the surfaces and counting of bladders was impossible in mature leaves due to the presence of cellulose material of bladder and salt debris. Salt excretion is enhanced with increase in size and number of bladders (Table 1). The young leaves in both the species exhibit a single layer of bladders and showed more anions and cations concentration when compared to the mature leaves. This may be due to the presence of more intact bladders on the surface of young leaves (Table 2). The present study indicates the difference in the size and variation in the shape of salt bladders in the two species studied.

Table 2. Variations in ionic concentrations (%) in young (Y.L.) and mature leaves (M.L.) in the two sdecies of *Atriplex*.

Species		Cl^-	Na^+	K^+	Ca^{++}
A. holcrapa	M.L.	14.6±2.6	16.7±0.6	0.7±0.01	0.87±0.11
	Y.L.	15.7±3.0	23.4±5.6	1 3±0.0	1.1 ±0.6
A. vesicaria	M.L.	13.6±2.0	11.5±2.0	2.9±0.07	I.08±0.9
	Y.L.	15.0±1.0	20.8±1.8	4.7±0.4	2.5 ±0.1

ACKNOWLEDGEMENTS

The help rendered by Dr. N.S. Shekhawat for microphotograph facilities and Texas Tech. Units, Tuson, USA for providing seeds is acknowledged.

REFERENCES

Goon, J.R. and Mozafar, A. 1972. Physiology of salinity stress. In: *Wildland shrubs–Their biology and utilization* (eds.) C.M. McKell, J.P. Blaisdell and J.R. Goodin, pp. 255-259. U.S. Department of Agriculture and Forest Service Technical Report. INT-1.

Mozafar, A. and Goodin, J.R. 1970. Vesiculated hairs: a mechanism for salt tolerance in *Atriplex halimus* L. Plant Physiology 45: 62-65.

Osmond, B, 1963, Oxalates and ionic equilibria in Australian salt bushes *(Atriplex)*. Nature 198 (4879) : 503-504.

Osmond, C.B., Bjorkmen, O. and Anderson, D.J. 1980. *Physiological processes in plant ecology; towards a synthesis with Atriplex.* Ecological Studies No. 36, Springer, Berlin.

Storey, R., Ahmed, N. and Wyn Jones, R.G. 1977. Taxonomic and ecological aspects of the distribution of glycine-betain and related compounds in plants. *Oecolagia* 27: 319-322.

Waisel, Y. 1972. *Biology of Halophytes*. Acad. Press, New York.

West, K.R. 1970. The anatomy of *Atriplex* species. In: *The Biology of Atriplex* (ed.) R. Jones. pp. 11-15. CSIRO, Deniliquin.

Wood, J.G. 1925. The selective absorption of chlorine ions and absorption of water by the leaves of the genus *Atriplex*. Australian Journal of Experimental Biology and Medical Science 2: 45-56.