

Distribution, diversity and utilization of *Haloxylon salicornicum*: A rangeland shrub of arid regions

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Keywords: Arid, Feed, *Haloxylon*, Rangeland

Introduction

Livestock systems occupy ~ 30 % of the planet's ice – free terrestrial area, contributes about 40 % to the agricultural GDP and directly supports the livelihoods of 600 million poor smallholder farmers in the developing world. Livestock play multiple roles (societal, economic and environmental) in the livelihoods of people in communities, especially the poor. Therefore the sustainable livestock production is an imperative to nutritional and livelihood security globally. *Haloxylon salicornicum* is an important rangeland shrub species of arid regions. The species possesses range of morphological, physiological and ecological adaptation to survive under water limiting, nutrient poor environmental conditions of arid regions. It is used as a fodder, medicine and in restoration of degraded arid lands. However, information about this species is fragmentary and meager, which hinders its development and sustainable utilization. This paper aims to summarize information regarding distribution, agro-morphological diversity and uses of *H. salicornicum* to stimulate interest in this species.

Materials and Methods

Survey was conducted in different places of north western Rajasthan, India to collect germplasm of *H. salicornicum* during 2001-2002. In each location 200-500 well matured seeds from a single shrub were collected. Six-month-old seedlings were transplanted in August 2002 after receiving rainfall. Six plants of each accession were planted at 2 m apart in a row. A total of 65 rows each consisting six plants of one accessions were planted at RRS, Bikaner, Rajasthan, India. Three morphological characters including plant diameter, number of branch per plant and canopy diameter were recorded at annual interval. The foliage, seed and total aboveground biomass yields were recorded at 7 years after planting. The information pertaining to distribution, and utilization were collected from published literatures.

Results and Discussion

Distribution: The *H. salicornicum* is distributed in Northern Africa and Asia, in both temperate and tropical regions particularly in Egypt, Palestine, Jordan, Iraq, Iran, Pakistan, India and Kuwait. In India, it occurs in Punjab and North-western Rajasthan. In North-western Rajasthan it is distributed between 26 – 28 °N latitude and 69 -73° E longitudes (Shankar and Kumar, 1984) comprising Bikaner, Jaisalmer and Sriganganagar districts. In hot arid regions of India, It is often the dominant plant species on sandy undulating hummocky plains, dunes, and inter-dunes.

Agro-morphological diversity: The collected accessions exhibited remarkable diversity for plant height, number of branches, canopy area and yields (Table 1). The variations among different accessions in terms of plant height varied from 21-99, 48-111, 56-125 and 51-140 cm recorded at 1, 3, 5 and 7 year after planting, respectively. The number of branch per plant ranged from 7-38, 10-44, 11-36 and 12-31 at 2, 4, 8 and 10 years after planting, respectively. The canopy area ranged from 0.56-2.51, 0.90-3.12, 1.10 – 3.44, 1.22 -3.65 and 1.55-3.66 m² at 2, 4, 6, 8 and 10 year after planting, respectively. Number of branch per plant and canopy area had greater variability compared to plant height. The foliage yields differed considerably among the accessions. The foliage yields had greater variability (CV 43%) compared to seed yield (CV 33%).

Table 1: Growth and yield of *Haloxylon salicornicum*

	Year after planting				
	2	4	6	8	10
<i>Growth attributes</i>					
Plant height (cm)	86 ± 8	90 ± 7	99 ± 10	102 ± 10	99 ± 9
Number of branches (n. plant ⁻¹)	16.8 ± 4	25.2 ± 4	20.1 ± 3	19.3 ± 3	21.0 ± 3.0
Canopy area (m ² plant ⁻¹)	1.53 ± 0.3	1.90 ± 0.4	2.11 ± 0.3	23.3 ± 0.3	24.5 ± 0.3
<i>Yield</i>	7 year after planting				
Foliage yield (g plant ⁻¹)	1209 ± 87				
Seed yield (g plant ⁻¹)	124 ± 22				

Uses

Livestock feed: Shrubs have been used as feed resources in arid regions; and many of these species provide a valuable reserve feed for livestock under drought conditions or fill regular gaps in feed supply caused by seasonal conditions. Rathore *et al.* (2011) have highlighted significance of shrubs as feed resources in hot arid region of India.

H. salicornicum is an important feed resource for camel in Kuwait, Pakistan, and India. It is an important feed resource for camel and small ruminants in north western Rajasthan. The *H. salicornicum* together with grass species *Lasiurus indicus* forms a very productive grazing land in the hot arid region of India (Shankar and Kumar 1984). Phenology of these two groups of plant complements each other with respect to period of feed availability. In hot arid region of India, its green twigs and flowering tops are harvested and stored for using in lean period. Generally it is fed after mixing with straw and left over threshed materials of *Cyamopsis tetragonoloba* and dry phylloclade of *Calligonum polygonoides*. Singh *et al.* (2015) gave detailed account of its feed importance. The fruiting top is more nutritious than twigs (Table 2). Seeds with perianth contain 18.2 % CP, 1.8 % CP, 13.9 % CF and 35.9 % ADF (Mathur *et al.*, 2011).

Table 2. Nutritional composition of *Haloxylon salicornicum*

	% (DM)				
	Crude protein	Ether extract	Ash	Neutral detergent fiber	Acid detergent fiber
Fruiting top	14.0-18.9	1.0-1.5	20.7-23.9	36.3-50.4	18.7-23.4
Twig	11.3-14.8	0.5-0.7	8.9-15.1	51.7-64.2	31.9-45.3

Six-week feeding trials on goat were conducted to evaluate feeding value of seed (Mathur *et al.*, 2011). Results suggest that seeds of *H. salicornicum* are palatable and could replace 50 % of the concentrate feed, and resulted in substantial reduction in feeding cost of goat in arid regions. Results of a feeding experiment on cattle conducted at Bikaner, India indicated that seeds of *H. salicornicum* can be safely included in the concentrate replacing 25% Til (*Sesamum indicum*) seed cake of the concentrate in the ration of lactating cattle (Mathur *et al.*, 2011). It increased milk production, with higher percentage of fat, protein and SNF. The results of a feeding trial on camel indicated that substitution of conventional concentrate feed @ 25 % by seeds of *H. salicornicum* had no adverse effects on DM intake, body weight gain and digestibility of nutrients. Digestibility of DM, CP, EE, CF, NDF, ADF, NFE was 70.1, 63.8, 82.6, 72.7, 61.1, 63.3, 63.9 %, respectively.

Traditional medicine and modern pharmacology: *H. salicornicum* has been used in traditional or folklore medicine for cure of number of diseases and disorders and contains an array of bioactive phytochemicals. Singh *et al.* (2015) gave detailed account medicinal properties and phytochemicals isolated from *H. salicornicum*.

Restoration of degraded lands: *H. salicornicum* is a promising species for re-vegetation and sand dune fixation in arid and semi- arid regions. Phytogenic miniature dunes of *H. salicornicum* facilitate plant establishment. Results of a study conducted in hot arid region of India indicated that establishment of *H. salicornicum* increased silt + clay content, enhanced water holding capacity, organic carbon, available nitrogen, available phosphorus, and electrical conductivity; and decreased pH, and bulk density. Furthermore, density and biomass of herbaceous plants in alleys of *H. salicornicum* was 1.2 and 1.6 fold greater than open area (Rathore *et al.*, 2015).

Conclusion

H. salicornicum is an important source of feed, bioactive phytochemicals and has potential for restoration of degraded arid lands. It can withstand environmental stresses and can be grown on marginal lands. Having good abiotic stresses (drought, high temperature and salinity) tolerance, it should be considered as a potential species adapted to anticipated climate

change. The considerable degree of variability between accessions for agro-morphological characters can be strongly useful to perform future programs of conservation in situ and ex situ, in order to expand and improve its utilization. Taking into account all these aspects and features, *H. salicornicum* seems to be a suitable candidate for further domestication and commercialization as a multipurpose shrub species for arid regions.

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