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HALOXYLON SALICORNICUM - AN ARID LAND SHRUB : IT'S ECOLOGY AND POTENTIAL

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ABSTRACT

Haloxylon salicornicum (Moq.) Bunge, a succulent dwarf chenoped shrub, grows naturally in the extreme arid regions of the world. It is an important forage shrub as it remains green and available to the livestock during the lean period (November-March) when the green pasturage is scarce. It is also used as a descaling agent for locomotive boilers as it contains high percentage of oxalic acid. Some new piperidine alkaloids have also been isolated from this shrub. Several aspects of its biology and utilization have also been studied. These findings have been described and discussed in this paper. Gaps in the available information and future line of research have also been indicated.

INTRODUCTION

Haloxylon salicornicum, a desert shrub has attracted attention of several researchers (Al-Ani *et al.*, 1970, 1971, 1973 and 1974; Clor *et al.*, 1973 and 1974; Thalen 1974 and 1979; and Shankar and Kumar, 1982 and 1984) and many aspects of its ecology and productivity have been studied in detail. Here an attempt has been made to pool up the available information from the diffused literature, and to identify the missing links on which the future research planning is to be based.

TAXONOMY

Hooker reported *H. salicornicum* in 1885 from British territories in India. From the Indian subcontinent it was recorded in 1917 by Blatter and Hallberg from the Sodakoer river in the Jaisalmer district of Rajasthan. It was first named by them *Arthrophytum salicornicum*, and lateron, *H. salicornicum* (Moq.) Bunge. Detailed taxonomy of this plant has been reported by Saksena (1973), Mertia (1975) and Bhandari (1978).

MORPHOLOGY

H. salicornicum is a succulent, dwarf, branching shrub of the family *Chenopodiaceae*. Branches arise from the basal woody part which is often partly covered with sandy hummock (Agnew, 1961). It's wide-spread and deep tap root system (Shankar and Kumar, 1984) extends beyond 5 m and it is estimated to go 8 to 10 m deep. Spreading leaves are 4-9 mm long (Mertia, 1975). Two biotypes, one with white and the other

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GEOGRAPHICAL DISTRIBUTION

Blatter and Hallberg (1917) reported it from Baluchistan (Pakistan) and Afghanistan. Dickson (1955) and Kernick, (1966) described this plant as a common shrub of hard gravel and sandy gravelly areas in Kuwait. Freiteg (1971) reported its occurrence in the extreme desert of Afghanistan. Its presence in the arid zone of Iran was recorded by Zohary (1973).

In India it has a restricted distribution in the Punjab and northwest Rajasthan. In western Rajasthan its geographical and ecological distribution has been studied in detail by Shankar and Kumar (1984) who observed its concentration in the northwest of the great Indian desert confined to 26°-28° N latitude and 69°-73° E longitude. Its distribution is discontinuous and patchy. Wide-spread distribution of this plant was recorded in the northern parts of the Pokaran and Jaisalmer tehsils of Jaisalmer district. In the southern part of Jaisalmer district and the bordering area of Barmer district it is absent. In Bikaner it is confined to a small area in the south-western part. Its luxuriant growth has been observed along the Indira Gandhi Canal specially from Chinnu to Ramgarh (Fig. 1).

ECOLOGICAL DISTRIBUTION

Haloxylon salicornicum prefers the area with the minimum rainfall of 100 mm (Thalen, 1979). It's habitat characteristics in different parts of the world are almost similar. Fitzgerald (1957) observed this plant in shallow runnels, on alluvial fans and in shallow silty pans in eastern Arabia. In Kuwait 'hard gravel' and 'sandy gravelly' areas are its preferred habitats (Kernick, 1966), whereas in Iraq it occurs on low dunes (Dougramji and Kaul, 1971). The soil under *H. salicornicum* cover is of coarser type, often with a compact top layer or a gravelly top soil and hard gypsiferous and calcareous layers (Thalen 1979). The plant tolerates mild salinity. Thalen (1979) considered the following statement of Guest (1966) as correct but oversimplified assessment of the occurrence of *H. salicornicum* on a variety of environmental conditions in Iraq as well as neighbouring countries: "We agree with Long (1956) that the community is mainly found on rather sandy loam soils with underlying calcareous matter, casual excavation at one or two places has revealed a thin layer of finely broken calcareous rock under the sandy top soil, with solid gypsum below at a depth of 25-50 cm".

In India sandy undulating plains, sandy plains and interdunal areas are the preferred habitats of *H. salicornicum* (Shankar and Kumar, 1984). Its niche requirement is

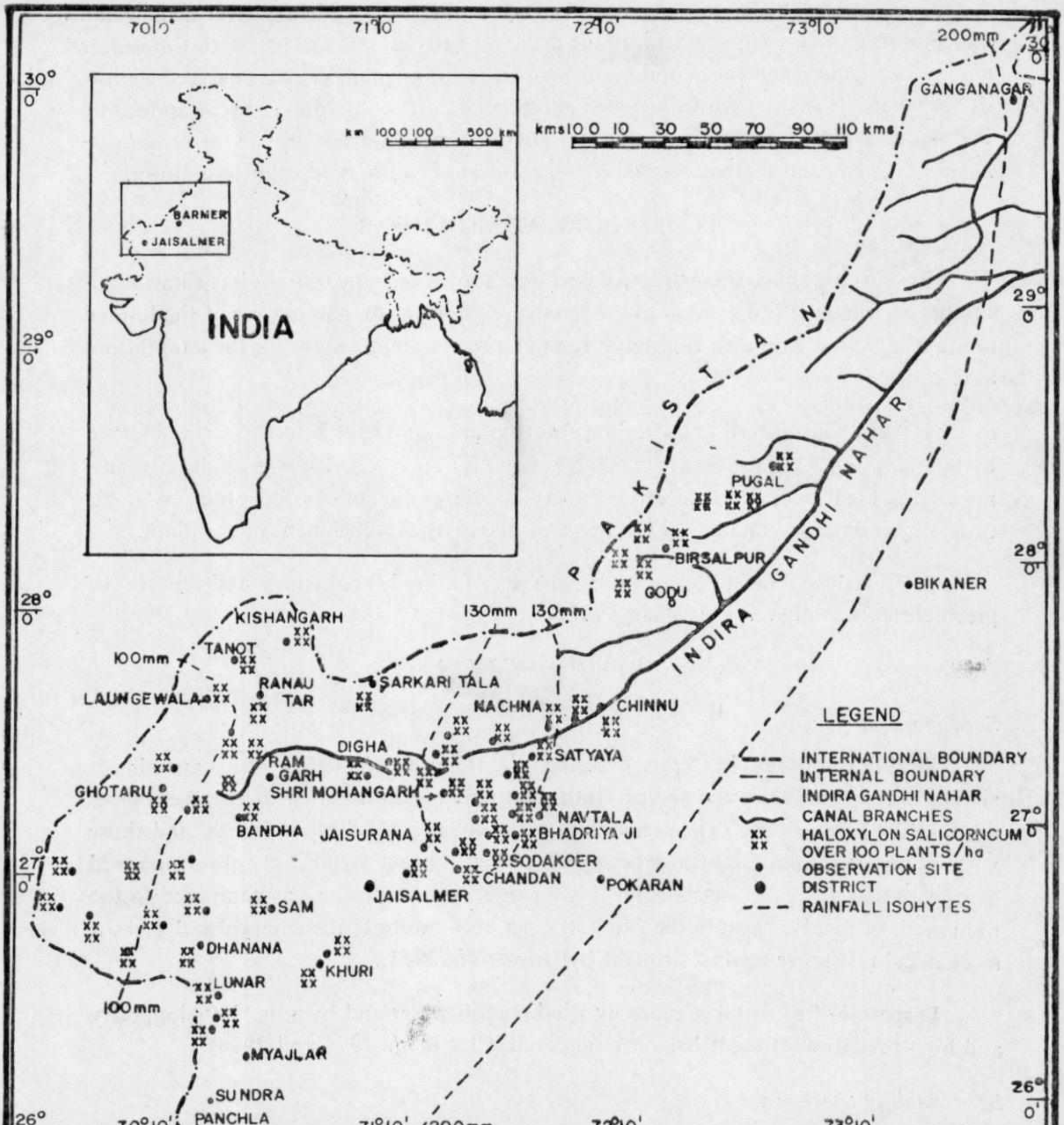


Fig.I. – DISTRIBUTION PATTERN OF HALOXYLON SALICORNICUM (Moq) Bunge .

best fulfilled in the dry beds of prior courses of the river Saraswati, sand dunes and sandy undulating interdunal plains underlain with gypsum at varying depths. Concen trated and luxuriant growth of *H. salicornicum* is observed in the dry river beds which indicates its moisture requirement. In the dry river beds it is associated with *Calotropis procera*, *Ziziphus nummularia* and *Crotalaria burhia*. The plant is also observed on low dunes where it occurs with *Calligonum polygonoides*. The interdunal areas and sandy undulating plains underlain with gypsum are favourable for the growth of *H. salicornicum* (Shankar and Kumar, 1984). *H. salicornicum* favours mild saline condition.

ECOLOGICAL ADAPTATIONS

To survive under the extreme desert conditions, *H. salicornicum* has some adaptability by which it can survive in the harsh environment by making use of the limited amount of water available through irregular precipitation. Some of the adaptations are :

1. Very wide-spread and deep tap root system. An exposed root system observed by Shankar and Kumar (1984) extended beyond 5 m (Fig. 2). Their estimate is that it must be going deeper down to 8-10 m. Very fast development of root, observed at the time of germination (Thalen, 1979), helps in the early establishment of the plant.

2. To reduce transpiration losses, the seasonal body reduction and removal of green cortex was observed (Zohary, 1962).

REPRODUCTION

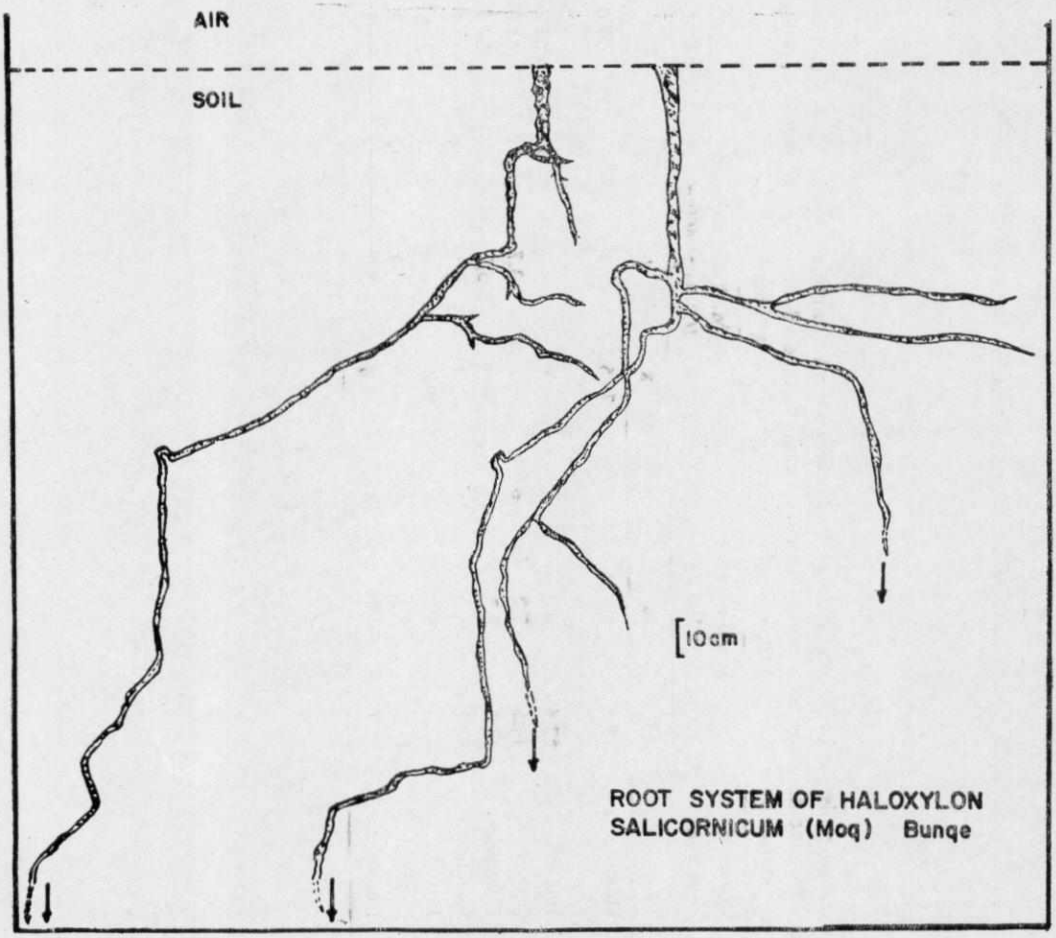
Seed morphology :

Seed morphology has been described by Clor *et al.* (1974). Seeds are almost similar in shape and size and the perianth that remains attached with the seeds gives a wing like appearance. The seeds with perianth are called husked seeds and those without perianth unhusked. Presence of the perianth has a significant role in the seed germination. The husked seeds show higher rate of germination as compared to the unhusked, probably because the wing like perianth protects the embryo and gives it mechanical resistance against drought (Al-Ani *et al.*, 1971).

Dispersal of seeds takes place by wind, runoff water and by ants. Less longevity and high predation of seeds has been observed (Clor *et al.*, 1973 and 1976).

Seed viability :

The seeds remain viable for approximately one year. Hammouda aud Bakr (1969) observed gradual loss of seed viability to zero within a period of one year. Clor *et al.* (1973 and 1976) reported 50 per cent decrease in the germination capability at room temperature. These observations were supported by Thalen (1979). Clor *et al.* (1976) also noted that small seeds lose their viability faster than larger seeds.



ROOT SYSTEM OF HALOXYLON SALICORNICUM (Moq) Bunqe

Table 1. Percentage moisture in different parts of *H. salicornicum* plants in three weight classes, collected near Khaidir Iraq at four different dates over the growing season (X-mean, S–standard deviation, n – number of observation) (Thalen, 1979) Percent moisture for plants of three weight classes on fresh weight basis.

	Month of collection	Small plants < 100 g			Medium plants 100 to > 400 g			Large plants < 400 g		
		x	s	n	x	s	n	x	s	n
Current season's growth	March	75.8	5.9	13	75.5	5.1	11	71.0	5.1	6
	July	52.4	4.2	9	56.0	4.9	11	52.9	2.9	10
	October	44.5	7.2	6	53.2	3.7	12	51.0	9.0	12
	December	28.3	8.3	10	30.4	5.7	14	29.2	4.6	6
Older material	March	37.9	3.2	13	32.4	3.3	11	27.5	7.2	6
	July	41.6	8.0	9	38.1	6.6	11	36.5	9.0	10
	October	17.2	5.3	6	19.8	5.4	12	20.3	4.5	12
	December	15.9	4.7	10	19.8	2.9	14	21.8	1.7	6

Seed germination :

Reproduction through seeds has been studied by many workers but there is no published literature on its vegetative propogation. The germination is epigeal type. Germination processes as affected by temperature, moisture and light have been studied by Hammouda and Bakr (1969), Al-Ani *et al.* (1971), Clor *et al.* (1974) and Thalen (1979). Germination rate is reported to be dependent on temperature and seed viability (Clor *et al.*, 1974). The rate of germination is higher under continuous dark, in comparison to continuous light conditions (Hammouda and Bakr, 1969). Observations of Al-Ani *et al.* (1971) under continuous light, intermittant light and continuous darkness, however, show no significant difference in percentage germination. But All-Mufti's (Pers. comm.) observations on slight increase in seed germination under continuous darkness does lend support to the findings of Hammouda and Bakr (1969). Sufficient soil moisture in the top soil is important for its seed-germi nation. Best development of the seedlings was observed (Clor *et al.*, 1974) at constant temperature 20°C. At the time of germination, development of root was observed to be much faster than that of the shoot.

MOISTURE CONTENT

Living plants always contain water which under certain conditions can be sufficient for an animals requirement. Thalen (1979) investigated percent moisture available in different parts of *H. salicornicum* and concluded that its moisture content, as a whole, only drops steeply in November. As a grazing plant for extreme arid areas it is important especially in relation to availability of water to the grazing animals.

NUTRITIVE VALUE

Several workers Al-Ani *et al.*, 1971; and Al-Ani and Jawad, 1973 and 1974, have reported the nutritive value of *H. salicornicum* as a forage plant. These studies show that it has high nutritive value (Table 2). Calcium content is very high in *H. salicornicum* ranging from 3.5 to 10.3 per cent from base to top. It has high magnesium content too.

Table 2. Nutritive value of *H. salicornicum* (Al-Ani *et al.*, 1971)

Nature of the sample	Date of collection	Moisture (%)	Ether extract (%) fat	Crude protein (%)	Crude fibre (%)	Ash mineral content	Nitrogen free extract
Older branch	Oct. 1972	4.73	0.83	1.10	28.68	5.96	52.70
Current growth	Oct. 1972	5.15	1.07	8.15	15.67	16.26	53.70
Seeds	Dec. 1972	2 91	2.70	14.34	10.20	24.23	45.62

CHEMISTRY OF AERIAL PARTS

The leaves and flowers of *H. salicornicum* are reported (Forest Research India, 1960) to contain free organic acids as oxalic acid-O.22 per cent, combined organic acid as oxalic acid-4.70 per cent, total organic acid as oxalic acid 4.92 per cent; tannins-31 per cent, non-tannins-38.3 per cent and fatty matters-3.68 per cent.

Table 3. Distribution of selected mineral constitutents in *H. salicornicum* in relation to height expressed in percentages of dry matter (Al-Ani and Jawad, 1973)

Nutrients	0–10	10–20	20–30	30-40	40–50	50–60	60–70
Na	0.5	1.0	1.3	1.6	2.2	2.3	—
K	0.7	1.0	1.1	1.0	1.2	1.2	—
Ca	3.5	5.6	6.2	7.9	6.3	10.3	—
Mg	0.7	1.6	2.0	2.1	2.0	2.6	—
Ash	14.9	25.3	29.3	37.0	36.4	—	—

On the basis of this analytical picture a descaling power was formulated from oxalic acid, soda ash, tannin extract and tamarind kernel power for locomotive boilers.

Studies on the biosynthesis of the alkaloids of *H. salicornicum* led to discovery of some new piperidine alkaloids (Donovan and Creedon, 1971). Piperidine is used as an accelerator in the vulcanization of rubber.

SALT TOLERANCE

Salt content in *H. salicornicum* from stem and root has been analysed (Table 4) by Choudhri and Shah (1963). They concluded that it absorbs salt from the deeper layers of soil and ultimately deposits them on the top soil and, therefore, it is responsible for further deterioration of the saline soils. In case the salt accumulating organs are removed before they are shed, salt concentration in the soil may be reduced.

CUTTING AND GRAZING EFFECTS

Studies of Thalen (1979) on the effect of cutting and grazing on *H. salicornicum* reveal that this plant could resist cutting and grazing. Regular grazing, and perhaps also moderate cutting are apparently beneficial and even necessary for continued growth of *H. salicornicum*. But frequent cutting and grazing has the inevitable effect resulting in the death of the plant. Thalen (1979) investigated the influence of different cutting treatments on the amount of regrowth as this species is most widely cut for fuel. In an experiment, all the plants in an area of 32 x 64 m^2 were cut at surface level. The final response to different cuttings was recorded and it showed that cutting the plants thrice in just over a year reduced the crown cover to almost nil. Plants cut once recovered extremely well, whereas those cut twice held an intermediate position. He concluded that large plants show more resistance to repeated cuttings than small-sized plants.

Table 4. Salt content in H. Salicornicum (Choudhri and Shah, 1963)

	STEM			ROOTS		
Place of collection	Fresh weight g	Dry weight g	Salt content (% of dry weight)	Fresh weight g	Dry weight g	Salt content (% of dry weight)
Jamshoro (Pakistan)	100.00	63.0	16.8	100.00	68.0	5.2

PRESENT USES

The plant is very useful as fodder in arid lands. Importance of this plant is due to its availability in the lean period (November-March) when the vegetation is scarce and grasses are grazed up. With dry grasses it makes highly nutritive feed for the animals. If the salt accumulating organs are removed at an early stage the plant will be helpful for salt reclamation.The harvested parts of *H salicornicum* can be used for manufacturing *Sajji* which is a crude product consisting of sodium bicarbonate. It is manufactured by burning *H. salicornicum.* It is also an effective descaling agent for locomotive boilers (Forest Research India 1960). Donovan and Creedon (1971) have shown biosynthetic importance of *H. salicornicum* in getting some new piperidine alkaloids, aldotripiperidine, halosaline, haloxine and anabasine from this plant.

MISSING LINKS AND FUTURE RESEARCH

Through this review of the available information on *H. salicornicum* it is now possible to identify the following information gaps :

High predation and poor longevity (less than one year) of seeds are reported in *H. salicornicum*. This calls for finding out modes of vegeta;ive propogation and standardizing them for large scale production of plants in the nurseries. Surprisingly there is no published literature on this important aspect. There exists a good shrub - grass compatability between *H. salicornicem* and the predominant desert grass *Lasiurus sindicus* under natural conditions. However, there is no information available on the influence of varying density of *H. salicornicum* on the forage yield of the grasses growing in its association. This information will be particularly useful in silvipastoral programmes for the extreme desert areas wherein *H. salicornicum* along with *L. sindicus* makes the predominant vegetation cover. There is also not much of work on the precise defoliation threshold of *H. salicornicum* and, therefore, systematic studies on its growth and regrowth and also on the frequency and the intensity of defoliation are required.

The plant grows in the extreme desert areas but there are no studies on its stress physiology specially in relation to salinity and moisture stresses. There are reports on the morphological variations but there have been no systematic efforts on screening out ecotypes/varieties. Adequate information is available on its nutritive value but not enough on its feeding value in relation to a variety of desert livestock. These missing links in the overall biology and utilization of *H. salicornicum* would form the basis for formulating future research plans on this important plant.

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