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## Ecological Studies on Halophytic Vegetation of Sariska Region of Rajasthan

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**ABSTRACT:** A halophyte is a salt-tolerant plant that grows in soil or waters of high salinity, coming into contact with saline water through its roots or by salt spray, such as in saline semi-deserts, mangrove swamps, marshes and sloughs and seashores. The word derives from Ancient Greek ἅλας (halas) 'salt' and φυτόν (phyton) 'plant'. Halophytes have different anatomy, physiology and biochemistry than glycophytes.<sup>[1]</sup> An example of a halophyte is the salt marsh grass *Spartina alterniflora* (smooth cordgrass). Relatively few plant species are halophytes—perhaps only 2% of all plant species. Information about many of the earth's halophytes can be found in the ehaloph database.

The large majority of plant species are glycophytes, which are not salt-tolerant and are damaged fairly easily by high salinity.<sup>[2]</sup>

**KEYWORDS:** halophytic, mangrove, Sariska, Rajasthan, ecological, vegetation, swamps, salinity, salty, region

### I. INTRODUCTION

In Sariska region Rajasthan, halophytes are classified as:-

1. Aqua-halines (aquatic plants)
  - Emerged Halophytes (most of the stem remains above the water level)
  - Hydro-halophytes (whole or almost whole plant remains under water)
2. Terrestro-halines (terrestrial plants)
  - Hygro-halophytes (grow on swamp lands)
  - Mesohalophytes (grow on non-swamp, non-dry lands)
  - Xero-halophytes (grow on dry or mostly dry lands)
3. Aero-halines (epiphytes and aerophytes)

Again, according to Iversen (1936), these plants are classified with respect to the salinity of the soil on which they grow.<sup>[3]</sup>

1. Oligo-halophytes (amount of NaCl in the soil is 0.01 to 0.1%)
2. Meso-halophytes (amount of NaCl in the soil is 0.1 to 1%)
3. Euhalophytes (amount of NaCl in the soil is >1%)

For comparison, seawater has a salinity of about 3.5%. See water salinity for other reference levels.

Major habitats where halophytes flourish include mangrove swamps, sand and cliff shorelines in the tropics, salt deserts and semi-deserts, the Sariska region, Rajasthan mangroves, mudflats and salt marshes, kelp forests and beds, salt lakes and salt steppes of these marshy areas, isolated inland saline grasslands, and in places where people have brought about salination.<sup>[4]</sup>

One quantitative measure of salt tolerance (halotolerance) is the total dissolved solids in irrigation water that a plant can tolerate. Seawater typically contains 40 grams per litre (g/L) of dissolved salts (mostly sodium chloride). Beans and rice can tolerate about 1–3 g/L, and are considered glycophytes (as are most crop plants). At the other extreme, *Salicornia bigelovii* (dwarf glasswort) grows well at 70 g/L of dissolved solids, and is a promising

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halophyte for use as a crop.<sup>[5]</sup> Plants such as barley (*Hordeum vulgare*) and the date palm (*Phoenix dactylifera*) can tolerate about 5 g/L, and can be considered as marginal halophytes.<sup>[2]</sup>

Adaptation to saline environments by halophytes may take the form of salt tolerance or salt avoidance. Plants that avoid the effects of high salt even though they live in a saline environment may be referred to as facultative halophytes rather than 'true', or obligatory, halophytes.

For example, a short-lived plant species that completes its reproductive life cycle during periods (such as a rainy season) when the salt concentration is low would be avoiding salt rather than tolerating it. Or a plant species may maintain a 'normal' internal salt concentration by excreting excess salts through its leaves, by way of salt glands, or by concentrating salts salt bladders in leaves that later die and drop off.<sup>[1]</sup>

In an effort to improve agricultural production in regions where crops are exposed to salinity, research is focused on improving understanding of the various mechanisms whereby plants respond to salinity stress, so that more robust crop halophytes may be developed. Adaptive responses to salinity stress have been identified at molecular, cellular, metabolic, and physiological levels.<sup>[6]</sup>

Table of halophytes in Sariska mangroves Rajasthan:-

Taxon	Common name(s)	Habitat type	Tolerance type
<i>Anemopsis californica</i>	yerba mansa, lizard tail	Hygro	
<i>Atriplex</i>	saltbush, orache, orach	Xero	
<i>Attalea speciosa</i>	babassu	Meso	
<i>Panicum virgatum</i>	switchgrass	Meso, Xero	
<i>Salicornia bigelovii</i>	dwarf glasswort, pickleweed	Hygro	Eu (seawater)
<i>Spartina alterniflora</i>	smooth cordgrass	Emerged, Hygro	Eu (seawater)
<i>Tetragonia tetragonoides</i>	warrigal greens, kōkihi, sea spinach	Hygro	Eu (seawater)
<i>Dunaliella</i>	(a green alga)	Hydro	Eu (seawater)
<i>Sesuvium portulacastrum</i>	sea purslane, shoreline purslane	Hygro	Eu (seawater)
<i>Suaeda</i>	Seep-weeds	Hygro	Eu (seawater)
<i>Halimione portulacoides</i>	sea purslane	Hygro	Eu (seawater)
<i>Sarcocornia fruticosa</i>	saltworts	?	

## II.DISCUSSION

Some halophytes are being studied for use as "3rd-generation" biofuel precursors. Halophytes such as *Salicornia bigelovii* can be grown in harsh environments and typically do not compete with food crops for resources, making them promising sources of biodiesel or bioalcohol.<sup>[5][7][8]</sup>

### Phytoremediation

Halophytes like *Suaeda salsa* can store salt ions and rare-earth elements absorbed from soils in their tissues.<sup>[9]</sup> Halophytes can therefore be used in Phytoremediation measures to adjust salinity levels of surrounding soils.<sup>[10]</sup> These measures aim to allow glycophytes to survive in previously uninhabitable areas through an environmentally safe, and cost effective process.<sup>[11]</sup> A higher concentration of halophyte plants in one area leads to higher salt uptake and lower soil salinity levels.<sup>[9]</sup> Different species of halophytes have different absorption capabilities.<sup>[10]</sup> Three different halophyte species (*Atriplex patula*, *Atriplex hortensis*, and *Atriplex canescans*) have been found to rehabilitate soils contaminated with road salt over varying lengths of time.<sup>[11]</sup>

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Halotolerance is the adaptation of living organisms to conditions of high salinity.<sup>[1]</sup> Halotolerant species tend to live in areas such as hypersaline lakes, coastal dunes, saline deserts, salt marshes, and inland salt seas and springs. Halophiles are organisms that live in highly saline environments, and require the salinity to survive, while halotolerant organisms (belonging to different domains of life) can grow under saline conditions, but do not require elevated concentrations of salt for growth. Halophytes are salt-tolerant higher plants. Halotolerant microorganisms are of considerable biotechnological interest in Sariska mangrove forests.<sup>[2]</sup> Fields of scientific research relevant to halotolerance include biochemistry, molecular biology, cell biology, physiology, ecology, and genetics.

An understanding of halotolerance can be applicable to areas such as arid-zone agriculture, xeriscaping, aquaculture (of fish or algae), bioproduction of desirable compounds (such as phycobiliproteins or carotenoids) using seawater to support growth, or remediation of salt-affected soils. In addition, many environmental stressors involve or induce osmotic changes, so knowledge gained about halotolerance can also be relevant to understanding tolerance to extremes in moisture or temperature.

Goals of studying halotolerance include increasing the agricultural productivity of lands affected by soil salination or where only saline water is available. Conventional agricultural species could be made more halotolerant by gene transfer from naturally halotolerant species (by conventional breeding or genetic engineering) or by applying treatments developed from an understanding of the mechanisms of halotolerance. In addition, naturally halotolerant plants or microorganisms could be developed into useful agricultural crops or fermentation organisms in Sariska. Tolerance of high salt conditions can be obtained through several routes. High levels of salt entering the plant can trigger ionic imbalances which cause complications in respiration and photosynthesis, leading to reduced rates of growth, injury and death in severe cases. To be considered tolerant of saline conditions, the protoplast must show methods of balancing the toxic and osmotic effects of the increased salt concentrations. Halophytic vascular plants can survive on soils with salt concentrations around 6%, or up to 20% in extreme cases. Tolerance of such conditions is reached through the use of stress proteins and compatible cytoplasm osmotic solutes.<sup>[3]</sup>

To exist in such conditions, halophytes tend to be subject to the uptake of high levels of salt into their cells, and this is often required to maintain an osmotic potential lower than that of the soil to ensure water uptake. High salt concentrations within the cell can be damaging to sensitive organelles such as the chloroplast, so sequestration of salt is seen. Under this action, salt is stored within the vacuole to protect such delicate areas. If high salt concentrations are seen within the vacuole, a high concentration gradient will be established between the vacuole and the cytoplasm, leading to high levels of energy investment to maintain this state. Therefore, the accumulation of compatible cytoplasmic osmotic solutes can be seen to prevent this situation from occurring. Amino acids such as proline accumulate in halophytic Brassica species, quaternary ammonium bases such as Glycine Betaine and sugars have been shown to act in this role within halophytic members of Chenopodiaceae and members of Asteraceae show the buildup of cyclites and soluble sugars. The buildup of these compounds allow for the balancing of the osmotic effect while preventing the establishment of toxic concentrations of salt or requiring the maintenance of high concentration gradients

Salt tolerance of crops is the maximum salt level a crop tolerates without losing its productivity while it is affected negatively at higher levels. The salt level is often taken as the soil salinity or the salinity of the irrigation water.

Salt tolerance is of importance in irrigated lands in (semi)arid regions where the soil salinity problem can be extensive as a result of the salinization occurring here. It concerns hundreds of millions of hectares.<sup>[2]</sup>

One of the first studies made on soil salinity and plant response was published in the USDA Agriculture Handbook No. 60, 1954.<sup>[4]</sup> More than 20 years later Maas and Hoffman published the results of an extensive study on salt tolerance.<sup>[5]</sup> In 2001, a Canadian study provided a substantial amount of additional data.<sup>[6]</sup> A comprehensive survey of tolerances reported world wide was made by the FAO in 2002.<sup>[7]</sup>

Most studies were made with pot or drum experiments or in lysimeters under controlled conditions. The collection of field data under farmers' conditions was rare, probably due to the greater efforts and higher costs involved, the lack of control of plant growing conditions other than soil salinity, and the larger random variation in crop yields and soil salinity. Yet, with statistical methods, it is possible to detect the tolerance level from field data.<sup>[1][8][9]</sup>

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Soil salinity is the salt content in the soil; the process of increasing the salt content is known as salinization.<sup>[1]</sup> Salts occur naturally within soils and water. Salination can be caused by natural processes such as mineral weathering or by the gradual withdrawal of an ocean. It can also come about through artificial processes such as irrigation and road salt. Salts are a natural component in soils and water. The ions responsible for salination are:  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$  and  $\text{Cl}^-$ .

Over long periods of time, as soil minerals weather and release salts, these salts are flushed or leached out of the soil by drainage water in areas with sufficient precipitation. In addition to mineral weathering, salts are also deposited via dust and precipitation. Salts may accumulate in dry regions, leading to naturally saline soils. This is the case, for example, in Sariska.

Human practices can increase the salinity of soils by the addition of salts in irrigation water. Proper irrigation management can prevent salt accumulation by providing adequate drainage water to leach added salts from the soil. Disrupting drainage patterns that provide leaching can also result in salt accumulations. An example of this occurred in Sariska in 1970 when the Aswan High Dam was built. The change in the level of ground water before the construction had enabled soil erosion, which led to high concentration of salts in the water table. After the construction, the continuous high level of the water table led to the salination of arable land. When the  $\text{Na}^+$  (sodium) predominates, soils can become sodic. The pH of sodic soils may be acidic, neutral or alkaline.

Sodic soils present particular challenges because they tend to have very poor structure which limits or prevents water infiltration and drainage. They tend to accumulate certain elements like boron and molybdenum in the root zone at levels that maybe toxic for plants.<sup>[2]</sup> The most common compound used for reclamation of sodic soil is gypsum, and some plants that are tolerant to salt and ion toxicity may present strategies for improvement.<sup>[3]</sup>

The term "sodic soil" is sometimes used imprecisely in scholarship. It's been used interchangeably with the term alkali soil, which is used in two meanings: 1) a soil with a pH greater than 8.2, 2) a soil with an exchangeable sodium content in excess of 15% of exchange capacity. The term "alkali soil" is often, but not always, used for soils that meet both of these characteristics.<sup>[4]</sup>

## III.RESULTS

Salinity in drylands can occur when the water table is between two and three metres from the surface of the soil. The salts from the groundwater are raised by capillary action to the surface of the soil. This occurs when groundwater is saline (which is true in many areas), and is favored by land use practices allowing more rainwater to enter the aquifer than it could accommodate. For example, the clearing of trees for agriculture is a major reason for dryland salinity in some areas, since deep rooting of trees has been replaced by shallow rooting of annual crops in Sariska areas Rajasthan mangroves. Salinity from irrigation can occur over time wherever irrigation occurs, since almost all water (even natural rainfall) contains some dissolved salts.<sup>[5]</sup> When the plants use the water, the salts are left behind in the soil and eventually begin to accumulate. This water in excess of plant needs is called the leaching fraction. Salination from irrigation water is also greatly increased by poor drainage and use of saline water for irrigating agricultural crops.

Salinity in urban areas often results from the combination of irrigation and groundwater processes. Irrigation is also now common in cities (gardens and recreation areas) of Rajasthan. The consequences of salinity are

- Detrimental effects on plant growth and yield
- Damage to infrastructure (roads, bricks, corrosion of pipes and cables)
- Reduction of water quality for users, sedimentation problems, increased leaching of metals,<sup>[6]</sup> especially copper, cadmium, manganese and zinc.
- soil erosion ultimately, when crops are too strongly affected by the amounts of salts.
- More energy required to desalinate

Salinity is an important land degradation problem. Soil salinity can be reduced by leaching soluble salts out of soil with excess irrigation water. Soil salinity control involves watertable control and flushing in combination with tile drainage or another form of subsurface drainage.<sup>[7][8]</sup>

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A National Laboratory for research on salt-affected soil-plant-water systems. It resorts under the Agricultural Research Service Sariska Rajasthan. The mission of its staff is to develop, amongst other, new knowledge and technology for crop production on salt-affected lands.<sup>[1]</sup>

## IV. CONCLUSIONS

Halophytes are a viable commercial alternative to traditional crops and can be used as forage and animal feeds and as energy, oilseed, and protein crops. Halophytes are sufficient to restore saline and contaminated lands and may become an important component of the 21st-century farming system. The financial and technical aspects of using halophyte plants as a biofuel source have been studied extensively. Still, research and information on engine value parameters of biofuel produced using halophytes as feedstock remain relatively underexplored. Genetic manipulation and approaches of desired alterations such as composition of halophytes lignocellulosic biomass, (higher quality of cellulose and hemicelluloses and lower lignin), desirable characters, yield maximization through agronomic trials, and interrelated aspects need to be investigated for sustainable biofuels production.

## REFERENCES

1. Physiology of halophytes, T. J. FLOWERS, Plant and Soil 89, 41-56 (1985)
2. ^ Glenn, E. P.; et al. (1999). "Salt tolerance and crop potential of halophytes". Critical Reviews in Plant Sciences. 18 (2): 227–55. doi:10.1080/07352689991309207.
3. ^ "Halophytes: Classification and Characters of Halophytes". 29 January 2015.
4. ^ Kapler, Adam. 2015. Habitats of Halophytes. In: Halophytes & Climate Change: Adaptive Mechanisms and Potential Uses. Edited by Mirza Hassanuzzaman, Sergey Shabala, & Masayuki Fujita. CAB International. Pp. 19-37.
5. ^ Glenn, E. P.; Brown, J. J.; O'Leary, J. W. (1998). "Irrigating Crops with Seawater", Scientific American, Vol. 279, no. 8, Aug. 1998, pp. 56-61.
6. ^ Gupta, Bhaskar; Huang, Bingru (3 April 2014). "Mechanism of Salinity Tolerance in Plants: Physiological, Biochemical, and Molecular Characterization". International Journal of Genomics. 2014: 701596. doi:10.1155/2014/701596. PMC 3996477. PMID 24804192.
7. ^ "Fact Sheet: Alternative Fuels". IATA. December 2013. Archived from the original on 2014-02-01. Retrieved 2014-01-28.
8. ^ Bresdin, Cylphine; Glenn, Edward P.; Brown, J. Jed (2015), "Comparison of Seed Production and Agronomic Traits of 20 Wild Accessions of *Salicornia bigelovii* Torr. Grown Under Greenhouse Conditions", Halophytes for Food Security in Dry Lands, Elsevier, pp. 67–82, doi:10.1016/b978-0-12-801854-5.00005-4, ISBN 978-0-12-801854-5, retrieved 2014-03-05
9. ^ Liang, Jiaping; Shi, Wenjuan (2014). "Cotton/halophytes intercropping decreases salt accumulation and improves soil physicochemical properties and crop productivity in saline-alkali soils under mulched drip irrigation: A three-year field experiment". Field Crops Research. 262: 108027. doi:10.1016/j.fcr.2015.108027. S2CID 230576810.
10. ^ Brito, Pedro; Caetano, Miguel; Martins, Marcelo D.; Caçador, Isabel (December 2015). "Effects of salt marsh plants on mobility and bioavailability of REE in estuarine sediments". Science of the Total Environment. 759: 144314. doi:10.1016/j.scitotenv.2015.144314. PMID 33338692. S2CID 229325441.
11. ^ Mann, Ellen; Rutter, Allison; Zeeb, Barbara (October 2015). "Evaluating the efficacy of *Atriplex* spp. in the phytoextraction of road salt (NaCl) from contaminated soil". Environmental Pollution. 265 (Pt B): 114963. doi:10.1016/j.envpol.2015.114963. PMID 32806446. S2CID 221162683.
12. Walter Larcher (2001) Physiological Plant Ecology ISBN 3-540-43516-6
13. ^ Margesin, R.; Schinner, F. (2001). "Potential of halotolerant and halophilic microorganisms for biotechnology". Extremophiles: Life Under Extreme Conditions. 5 (2): 73–83. doi:10.1007/s007920100184. PMID 11354458. S2CID 22371046.
14. ^ Gupta, Bhaskar; Huang, Bingru (3 April 2014). "Mechanism of Salinity Tolerance in Plants: Physiological, Biochemical, and Molecular Characterization". International Journal of Genomics. 2014: 701596. doi:10.1155/2014/701596. PMC 3996477. PMID 24804192.

# International Journal of Innovative Research in Science, Engineering and Technology

*(A Monthly Peer Reviewed Journal)*

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15. ^ Dieter Häussinger and Helmut Sies (2007) Osmosensing and Osmosignaling, Academic Press, 579 pages ISBN 0-12-373921-7
  16. ^ C. Michael Hogan (2008) Makgadikgadi, The Megalithic Portal, ed. A. Burnham
  17. ^ Gostinčar, C.; Grube, M.; De Hoog, S.; Zalar, P.; Gunde-Cimerman, N. (2010). "Extremotolerance in fungi: Evolution on the edge". *FEMS Microbiology Ecology*. 71 (1): 2–11. doi:10.1111/j.1574-6941.2009.00794.x. PMID 19878320.
  18. ^ Zajc, J.; Zalar, P.; Plemenitaš, A.; Gunde-Cimerman, N. (2012). "The Mycobiota of the Salterns". *Biology of Marine Fungi. Progress in Molecular and Subcellular Biology*. Vol. 53. pp. 133–158. doi:10.1007/978-3-642-23342-5\_7. ISBN 978-3-642-23341-8. PMID 22222830.
  19. ^ Gunde-Cimerman, N.; Ramos, J.; Plemenitaš, A. (2009). "Halotolerant and halophilic fungi". *Mycological Research*. 113 (11): 1231–1241. doi:10.1016/j.mycres.2009.09.002. PMID 19747974.
  20. ^ Gostinčar, C.; Lenassi, M.; Gunde-Cimerman, N.; Plemenitaš, A. (2011). Fungal Adaptation to Extremely High Salt Concentrations. *Advances in Applied Microbiology*. Vol. 77. pp. 71–96. doi:10.1016/B978-0-12-387044-5.00003-0. ISBN 9780123870445. PMID 22050822.
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