

Halophytes:

Better option for food, fodder, fuel and medicinal purposes

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Soil salinization affects agriculture production worldwide. It threatens agricultural productivity in 77 mha agricultural land of which only 45 mha (20% of irrigated area) is irrigated. Salinity affects the growth, development and productivity of main crops worldwide because of the high stress conditions. Under such extreme stress conditions halophytes can prove to be a better option for food, fodder, fuel and medicinal purposes. These plants grow even under stress environments because they have special mechanisms to defend themselves against salinity. They can be used for various purposes to meet the rising demands of a growing population.

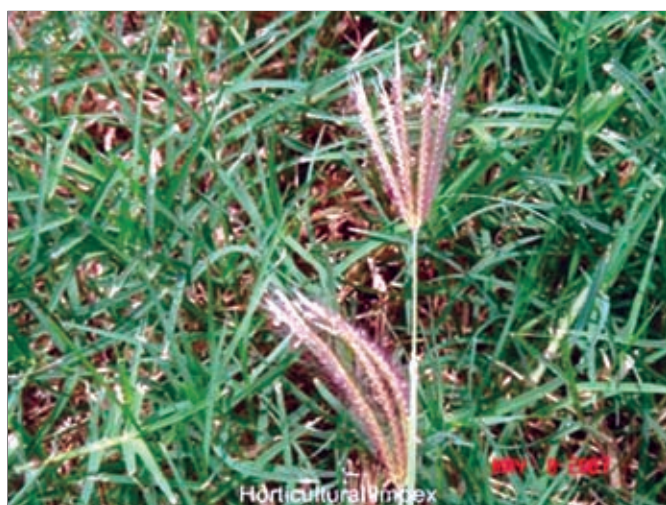
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SALINITY of soil, one of the major problems affecting the agricultural production worldwide, has become a major challenge in irrigated and semi-irrigated regions of the world where irrigation is essential to increase agriculture production. Globally more than 900 mha of land is affected by salts which accounts for more than 6% world's total land area. In India, salt affected soils occupy an area of about 6.94 mha of which saline soils and sodic soils constitute roughly 40% and 60% respectively. States like Uttar

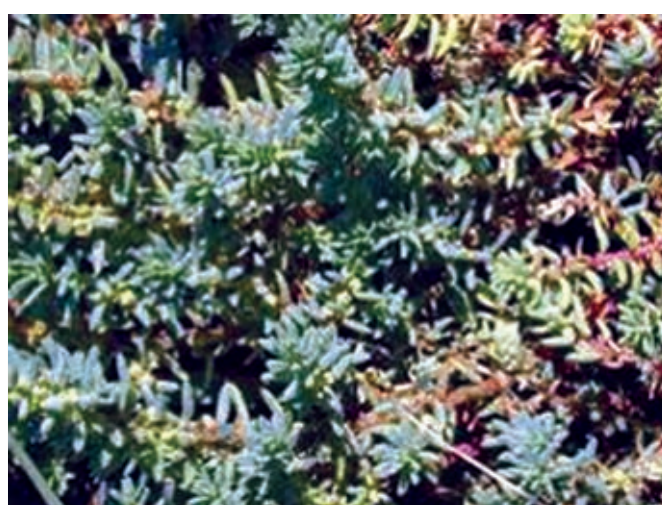
Pradesh, West Bengal, Punjab, Haryana are most affected by soil salinity. Farmers are afraid that these conditions may become unfavorable for their agriculture production. Traditional crops are unable to survive under soil salinity. Wheat crop shows decrease in average yield by more than 50% due to which stable supply of food becomes a question. Growing salt tolerant crops is also not a viable option because they can tolerate salinity up to 10 dS/m. Soil salinity threatens agricultural productivity in 77 mha of agricultural

land, of which only 45 mha (20% of irrigated area) is irrigated. Under these extreme situations of soil and water salinity, alternative options are needed in future to increase agriculture productivity in order to meet the growing demands of food and fodder for rising population.

Halophytes can be a viable option to grow under high salinity conditions because they can be used for forage production, soil rehabilitation, bio-energy generation, landscaping, carbon sequestration and other purposes. Halophytes can



Dicanthium annulatum



Suaeda nudiflora



be suitable alternatives and can help develop ecologically sustainable and economically sound biological systems that can use poor quality water and drought affected saline lands to give benefits to farmers in future.

Halophytes survive and reproduce in environments where salt concentration is around 200 mM or more. These can tolerate high salinity levels in irrigation water in some cases even higher than those in sea-water upto 60 dS/m. It is documented that there are about 6000 plant species of terrestrial and tidal halophytes in the world and most of them belongs to family Chenopodiaceae and Poaceae. Halophytes are commonly found near seashores where mesophytes and fresh water hydrophytes cannot thrive well. Although these plants grow in the areas which are well saturated with water, yet they cannot avail the water because of high concentration of salts in the soils. Thus, halophytes are plants of physically wet, but physiologically dry habitats. Though the fact that only a small group of higher plants can grow in the saline habitats was recognized many hundred years ago yet not much information is available about them.

Mechanism of salt tolerance in halophytes

The mechanism of salt tolerance is of two types: those minimizing the entry of salts into the plants and those minimizing the concentration of salt in the cytoplasm. But normally halophytes deal with the problems of salinity in following ways: some of them avoid salinity, some evade salinity or resist it, and a few others tolerate salinity.

Classification of halophytes

Halophytes consist of large number of plants and some scientists classified them on different basis to gather more information about these halophytes. Halophyte classification under Indian conditions has been described here.

Halophytes in India are found in swam and marshy environments. So they are also called as mangroves. Mangrove are the trees and shrubs

inhabiting the coasts and river estuaries of tropical or subtropical seas. Plants occurring in mangrove vegetation belong to several families. Common mangrove plants are *Rhizophoramucronata*, *Kandeharheedii*, *Ceriopsroxburghiana*, *Bruguieragymnorhiza*, and many other plants belonging to the family Rhizophoraceae, *Avicennia officinalis* of the family verbinaceae, *Acanthus ilicifolius* (Acanthaceae), *Ardisiumilis* and *Aegiceras majus* of family Myrisinaceae, *Cassula* species (a very common plant of rice field in northern India belonging to the family compositae), *Cometes surattensis* (Caryophyllaceae) which is commonly found in western Asia, *Avicennia*, *Sechium edule* (Aroideae)—an Indomalayan plant, *Cryptaeorineciliata* (Aroideae), a common plant growing in the muddy banks of Ganga, *Poa*, *Festuca*, *Melacanna*, and *Oryza patnai* (rice) of family Gramineae, *Scirpodendron* of Cyperaceae and a number of other plants belonging to the families Palmae, Parkeriaceae, Chaenopodiaceae, Plumbaginaceae, Ficoideae, Euphorbiaceae.

Mangrove plants are very commonly found on some saline soils of Indo-Gangetic plains (Bay of Bengal, Sunderbun and Assam), in western India near the sea coasts of Mumbai and Kerala, in the banks of Gaumati and Godavari in south India, particularly in the regions where rivers meet the ocean, and in Andaman and Nicobar Islands.

The ecological conditions which are essential for the development of mangrove vegetation or halophytes are:

- shallow water with thick mud,
- waterlogged saline soil or sandy or loose soil or heavy clays containing large amount or organic matter,
- high rainfall, and
- high humidity in the atmosphere and cloudy weather.

Mangrove vegetation of Gangetic estuary, particularly of Sunderbun region is localized in the following three geographical zones:

- Southern coastal strip and southwestern part,
- Central zone, and

- North-eastern part.

The Central zone is characterized by climax forest of *Heritiera*. *Ceriops* is one of the dominant plant species on the higher grounds near the sea and at certain places it may form pure forest in Sunderbun.

Mangrove vegetation in the western sea coast of India is represented by the following plant communities:

- Avicennia alba* and *Avicennia officinalis* community.
- Acanthus ilicifolius* and *Avicennia alba* community.
- Suaeda fruticosa* populations,
- Pure community of *Salvadora* species,
- Sesuvium portula castrum* population, and
- Aeluropus repens* population.

Godavari delta in Andhra Pradesh shows characteristic mangrove vegetation of *Avicennia alba*, *Avicennia marina*, *Rhizophora*, *Bruguiera*, *Ceriops*, *Sonneratia*, *Acanthus ilicifolius*, *Myriostachya weightiana*, *Clerodendron inerme*, etc.

Importance of halophytes

Food purposes: Halophytes have the potential to serve the human kind for food purposes. Sugar beet (*Beta vulgaris*) is an important root crop and currently used for making sugar in different countries. It has been derived from halophytes. Eelgrass and Palmer's saltgrass from the Gulf of California in North America are seed plants that grow in ocean water and have been used as major food staples. Although the cultivated date palm, *Phoenix dactylifera*, is not a halophyte but there seems good evidence that it was domesticated from wild halophytic populations somewhere in the Middle East. Indeed the cultivated date can be irrigated with moderately brackish water without serious loss of yield. From the ashes of certain chenopodiaceous halophytes, particularly from *Arthrocnemum*, *Haloxylon*, *Salicornia*, *Salsola* and *Suaeda*, a carbonate of soda called barilla was at one time obtained in large quantities and exported for the soap and glass industries. In the 18th and 19th centuries, the major exporters of barilla were India and



North Africa, as well as the Camargue and adjacent regions of the Mediterranean littoral of France and Spain. To this day, *Suaeda fruticosa* and other chenopods are collected from the saline ranns of Rajasthan to make soap and baking soda for local use. The young leaves and shoots of *Batis maritima*, *Portulaca oleracea*, *Tetragonia tetragonoides*, *Salicornia* spp., and *Suaeda torreyana* have also all been used for salads and pickles in various parts of the world. *Salvadora oleoides* and *S. persica* yield edible fruits rich in oil and fat. Both are multi-purpose trees in NW India, providing wood, shade, fodder as well as the fruits. The potential use of *Salvadora* fruits as the source of an industrial non-edible oil has also been reviewed by some scientists in India.

Fodder purposes: Halophytes can serve better as feed and fodder for livestock. India have less fodder production than demand to feed its livestock population. At ICAR-CSSRI, Karnal, India, Some work done on halophytes proved that some halophytes like *Dicanthium annulatum*, *Suaedanudiflora* and *Urochondra Setulosa* can be used for fodder purposes. Halophytic grasses namely *Panicum turgidum* and *Desmostachyabi pinnata* as excellent candidate crops for fodder production in different parts of the world. This cropping system can produce about 50,000-60,000 kg/ha/year of fodder (fresh weight) on saline lands, which is as good as maize. *Atriplexx* sp. Are proved to be a better option as fodder in foreign countries. Another taxon which has attracted much attention as a fodder plant on soil affected by salinity and water logging is Kalar grass, *Leptochloa fusca* In India, Pakistan and

elsewhere, this salt and alkali-tolerant grass has been utilized for fodder production on previously unproductive lands.

Land reclamation purposes: Considerable interest also lies in various salt-tolerant species for re-vegetation and rehabilitation of surface mines or other drastically disturbed lands in arid and semiarid regions. The USDA Soil Conservation Service has selected several species for use in the western United States. The Australians have also made great progress. In Kenya, various halophyte trees and shrubs, e.g. *Conocarpus lancifolius*, have been planted directly in seaside quarries to produce fuel and fodder from otherwise useless land. One rather intriguing way of using halophytes in land reclamation is the production, from various species of *Plantago*, of a gum or glue used as a mulch binder to hold fibre and seed in place on steep slopes and sandy soils. Thus erosion from wind and rain can be eliminated or at least reduced until new vegetation is re-established.

Medicinal purposes: Ethnobotanical studies on coastal halophytes have been conducted, which revealed about 50 plant species with different medicinal properties. Different plant parts of these plants are used to treat 12 disease conditions however, the use of leaves was highest followed by whole plants. Proper identification of bioactive compounds responsible to cure different diseases may not only help in uplift of local pharmaceutical industry but also the socio-economic status of the people.

Other purposes: 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 bio-alcohol. The amount of freshwater resources is steadily decreasing over long periods of time. This has led to the act of harvesting halophytes in seawater in order not to alter the biomass and seed yield of the plant. This procedure has helped halophytes to be viewed as viable candidates for bioenergy crops. The main factors that make halophytes more viable for biofuel production are the oil made from the seed and the lignocellulosic biomass of the halophyte.

SUMMARY

Halophytes are remarkable plants which grow under stress conditions where other types of plants could not survive. Although they have not been recognized as plants of economic importance by the society till now. These remarkable plants can fulfill almost every requirement of human beings especially those related to food, fodder, fuel and medicines. With a little government/private sector support, the cultivation and conservation of such natural resources would result in sustainable maintenance and utilization of this plant wealth in development of many local industries and also the uplift of socio-economic status of the poor people. But some day in future, they will prove to be quite beneficial for the human population. They have the potential to revolutionize the future for us.

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Biofortified varieties developed

Eight biofortified varieties of various crops including rice, wheat, maize, pearl millet and lentil have been released and notified during 2018. DRR Dhan 48 (IET 24555) and DRR Dhan 49 (IET 24557) are high zinc (25.2 ppm) rice varieties. Three wheat varieties, viz. MACS 4028 (d) [high protein (14.7%), iron (46.1 ppm) and zinc (40.3 ppm)], Pusa Wheat 8777 (HI 8777) [Iron (48.7 ppm), zinc (43.6 ppm)] and UAS-334 [high protein (13.3%) and zinc (43.1 ppm)] have also been released. Two pearl millet hybrids, viz. AHB 1200 Fe (MH 2072) (AHB 1200) hybrid [high iron (77 ppm) and zinc (39 ppm)] and HHB 299 (MH 2076) [high iron (73 ppm) and zinc (41 ppm)] and lentil variety IPL 220 with high concentration of Fe, Zn and Se have been released and notified.

Courtesy: DARE/ICAR Annual Report 2018-19

