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Review Article

Halophytes a New Key for Developing Saline Regions {1} Classification

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Abstract

Halophytes are receiving more attention from plant scientist, for improvement of the performance of glycophytes in salt-affected soils, unfortunately, the major economic crops (Glycophytes) could not tolerate salinity conditions even low concentrations, Halophytes species are a diverse group of plants with varying degrees of actual salt tolerance, there are various classifications of halophytes based on different characters, as their chemical composition of the shoots, or their ability to secrete ions, as their characteristics of naturally saline habitats, on Physiological bases, and as Ecological types. There are many growth forms can be distinguished in the halophytic species, these growth forms reflect the high stress in the salt lands, some of this growth form Rhizomatous, Leafless succulent shrub, Leafy non-succulent herbs, Leafless tree, and Succulent herb. Halophytes has various life forms which reflect their response to the high salt levels, it includes Annual plants; Perennial; Perennial grass; Perennial sea grass; Perennial shrubs, Shrub; Fern; Parasitic perennial plant; Sea grass; Vine, and trees. Halophytes utilize two main strategies (Salt tolerance and Salt avoidance) to adapted and complete life cycle under highly saline conditions. Also, halophytes use various complicated mechanisms for survival under salinity environments by regulate ion concentrations in the cell, or exert excessive salt out of plant tissue.

Keywords: Halophyte; Perennial; Rhizomatous; Salt tolerance; Salt exclusion; Succulent shrub

Background

Halophytes plants have a notable ability to tolerate salinity conditions and it could grow and complete their life cycle under salinity condition up to 200 mM Sodium chloride (NaCl) or more. There are various definitions for halophytes but the most popular one is the plants that can survive and complete their life cycle in the presence of soil salinity at least equivalent to 200 mM NaCl [1]. Unfortunately, major plants are mostly glycophytes, and increasing soil salinity affected crop productivity which reduced more than 50% under salinity conditions [2]. Therefore, halophytes are receiving more attention from plant scientist, as a result, to increase soil salinity in different areas worldwide particularly in arid and semi-arid regions, due to high evaporation ratios, and, rising sea levels, associated with global warming, which reduce the yield of different crops [2], this reduction considered a serious problem facing the humanity in the near future due to rapidly growing of world population which will be more 9 billion by 2050 [3]. Consequently, there is more attention to produce new cultivars that have the potential for higher yield under salinity stress. Generally, some of the halophytes used for different purposes such as food, forage, medical therapy, and as a crude material. This article looks at the roles that halophytes can be played to increase salinity tolerate in most glycophytes plants, for enhancing crop efficiency and increase crop production under salinity conditions. To improving crop efficiency and increase food production under salinity conditions, it is need understanding the physiological and molecular basis of stress tolerance in halophytes.

Halophytes

Halophytes are remarkable plants tolerate salinities that most species cannot, also, have potential as important crops in saline agriculture [4], moreover, it's used for food, forage, medical plants, fiber, and industrial purposes, so, halophytes can be evaluated as agricultural crops [5]. The halophytes growth rate is stimulated at high salinity level from 150-300 mM NaCl; however, low salinity conditions inhibit their growth [6].

Halophytes Classification

Halophytes species are a diverse group of plants with varying degrees of actual salt tolerance, there are various classifications of

halophytes based on different characters, also, halophytes classified as their chemical composition of the shoots (physiotypes), or their ability to secrete ions (recreto-halophytes), or as their characteristics of naturally saline habitats, on Physiological bases, or as Ecological types.

A. Cushman (2001) [7] used salt glands expected to differentiate between halophytes which consists of two groups that respond differently to increasing soil salinity as following:

a) Obligate Halophytes: called also euhalophytes include varieties that need high constantly salt for optimal growth rate [8], it can even grow better under high saline conditions (about 200-300 mM NaCl which is 35-55% seawater salinity).

b) Facultative Halophytes: Plants have the ability to grow in salty soils, and their growth improved in the soil devoid of salt or under low salt levels like Kali komarovii, and Aster tripolium [9].

Both obligate and facultative halophytes depend on the availability of salt which required for their growth and tolerance for sodium salts.

B. Grigore and Toma [10] classified Halophytes to a new type as follow:

a) Extreme-Halophyte: it is adapted to the saline environment and grown exclusively in high salinity conditions, like (Chenopodiaceae, Salicornia, Suaeda, Halimione, and Petrosimonia) are well-adapted extreme halophytes, moreover, the habitat of these halophytes may be irreversible or reversible.

b) Mesohalophytes: by integrating anatomy observations with ecological factors (salinity).

However, Halophytes such as Atriplex, Bassia, and Camphorosma are not strictly related to increased salinity, therefore may be classified as Reversible halophytes.

Generally, different investigations cleared that water and different nutrients are important factors for halophytes growth, besides availability of salts in natural saline.

C. From the other side, Halophytes classified based on salt uptake and storage to three physiological types as follows:

a) Salt-secreting Halophytes: Halophytes are divided according to salt secretion to Exo recreto halophytes and Endo recreto halophytes:

i. **The Exorecreto Halophytes:** secrete salt from epidermal salt glands of leaves and stems, which include species of Limonium, Tamarix, Spartina, Avicennia, and Frankenia.

ii. Endorecreto halophytes release salt from epidermal bladders on the leaves like species of Atriplex and Chenopodium.

b) Euhalophytes (salt-diluting halophytes): These plants have succulent leaves and stems, species of Suaeda, Salsola, Petoroimonia, and Reaumria have succulent leaves, whereas, genera with succulent stems include Halostachys, Halocnemum, Ralidium, Kalidium, and Salicornia.

c) Pseudohalophytes (salt-excluding halophytes): include species like *Phragmites, Artemisia*, and *Juncus spp.,*

Ecological Types

Halophytes can be divided into three ecological types as follow:

Mesohalophytes: Usually grow in salt meadows, salt shrublands, and other semiarid habitats with moderate soil water content, meso halophytes include species of *Atriplex, Limonlum, Aeluropus, Apocynum, and Suaeda*.

xerohalophytes: Grow mainly in salt deserts, it includes species of *Haloxylon, Tamarix, Kalidium, Halocnemum, Halostachys, Suaeda, Glycyrrhiza, Zygophyyllum, and Anabasis aphylla*

Hydrohalophytes: it is divided into two groups as follow:

a) Emergent Halophytes: Grow in salt marsh and coastal marsh habitats; it includes the species of *Bruguiera, Kandelia, Rhizophora, Acanthus, Lumnitzera, Nypa, Sonneratia, Acrostichum, Hibiscus, Triglochin*, and *Salicornia*.

b) Submerged Halophytes: This group grows beneath the surface of seawater, and includes *Ruppia rostellata, Zostera merina, Phyllospadix japonica, Cymodocae spp., Halodule spp.,* and *Halophila spp*.

Halophytes Growth Form

There are many growth forms can be distinguished in the halophytic species, some of the species modified its organs to store the water [11], some of this growth form Rhizomatous growth form, Leaf less succulent shrub, Leafy non-succulent herbs, Sthorny shrub, Leafless tree, and Succulent herb.

Halophytes Life Form

There are many life forms can be distinguished in the halophytic species, these life forms reflect the high stress in the salt lands, it includes annual herbs; perennial; perennial grass; PSG-perennial sea grass; perennial shrubs, shrub; Fern; parasitic perennial plant; sea grass; submerged plant; Vine; and trees.

a) Annual plants: e.g. *Crypsis aculeate* from Family Poaceae

b) Perennial shrub: like *Tamarix nilotica* which belong to *Tamaricaceae* family

c) Perennial subshrub: like *Limoniun axillare* from *Plumbaginaceae* family.

d) Fern: *Acrostichum spp.,* from *Pteridaceae* family.

Halophytes Strategies for Tolerating High Salinity

Halophytes utilize different strategies to withstand and complete life cycle under highly saline conditions where most plants died. These strategies depend on changes at molecular, anatomical and morphological levels to adaptations.

Generally, there are two main strategies to adapt to salinity conditions:

a) Salt tolerance.

b) Salt avoidance.

The physiology basics of salinity tolerance in halophytes are:

a) Growth.

b) Osmotic adjustment.

c) Ion compartmentation.

d) Compatible solutes

Halophytes Mechanism for Salt Tolerance

Halophytes use various complicated mechanisms for survival under such harsh environments by regulate ion concentrations in the cell, or exert excessive salt out of plant tissue, some of these mechanisms:

a) Salt exclusion

b) Salt elimination

c) Salt succulence

d) Salt redistribution

e) Salt accumulates

Conclusion

Halophytes plants have a notable ability to tolerate salinity conditions and it could grow and complete their life cycle under salinity condition, halophytes considered potential resources for salt stress tolerance genes, therefore, halophytes are receiving more attention from plant scientist, for improvement of the performance of glycophytes in salt-affected regions. There are different classifications of halophytes have been suggested based on various characters such as the chemical composition of the shoots, or their ability to secrete ions, on Physiological bases, and as Ecological types. There are various growth forms can be distinguished in the halophytic species, also, halophytes have different life forms which reflect their response to the high salt levels.

Halophytes utilize two main strategies (Salt tolerance and Salt avoidance) to adapted and complete life cycle under highly saline conditions. Also, halophytes use various complicated mechanisms for survival under salinity environments by regulate ion concentrations in the cell or exert excessive salt out of plant tissue.

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