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Mini Review

Some Physiological Mechanisms of Salt Tolerance in the Glycophytes Plant: Overview

Waleed Fouad Abobatta*

Horticulture Research Institute, Agriculture Research Center, Egypt

***Corresponding Author:** Waleed Fouad Abobatta, Horticulture Research Institute, Agriculture Research Center, Egypt.

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Abstract

Glycophytes cannot resist salinity and eventually die under severity saline conditions, unfortunately, around of 98% economics plant species belong to this category, soil salinity considered a major problem in arid and semiarid region, it is reduced plant productivity all over the world, soil salinity increases from environmental factors and human activity, therefore salinity stress decreases agricultural production worldwide, salinity stress causes changes in numerous physiological and metabolic processes in plant tissue, glycophytes plant have different physiological mechanisms such as Ion Homeostasis, Compatible Solute, Antioxidant Regulation, and Polyamines production.

Keywords: Glycophytes; Salinity Stress; Salt Tolerance; Physiological Mechanisms

Background

Plants use different physiological and biochemical mechanisms to avoid salinity hazards and survive under high salt concentration in water and soils. Salinity considered one of the most critical biotic stresses that damage productivity of Glycophytes Plant all over the world [1]. Salinity stress includes changes in various physiological and metabolic processes, depending on severity and duration of the stress, and ultimately inhibits crop production [2].

Physiological mechanisms involve: Ion homeostasis and Salt Tolerance (compartmentalization), ion transport and uptake, biosynthesis of osmo protectants and compatible solutes, activation of antioxidant enzyme and synthesis of antioxidant compounds, synthesis of polyamines, generation of nitric oxide (NO), hormone modulation, Compatible Solute Accumulation, Osmotic Protection, and Antioxidant Regulation of Salinity Tolerance.

Also, Soil salinity is one of the major factors for soil degradations, salinity can arise from environmental factors or human activity like excessive irrigation, improper fertilizing program, in arid and semi-arid regions, therefore salinity stress decreases agricultural production worldwide.

The glycophytes plants

The glycophytes is that plant cannot resist salinity and eventually died under sever salinity conditions, unfortunately, major economics plant species belong to this category, around of 98 - 99% of economic plants are glycophytes and are intolerant to salt and are unable to successfully grow in saline soils [3]. Glycophytes typically exclude sodium and maintain low sodium levels in their tissues at around 0.2 to 2.0 g kg−1 [4], many plant species appear to preferentially absorb Potassium rather than Sodium, so that Na: K ratios in the soil are very important for plant growth [5].

Soil salinity

There is about 800 million hectares of cultivated lands worldwide affected by soil salinity, the saline soil generating an osmotic pressure in plant cell and reducing the total yields of most crops [6]. Consequently, ion toxicity, lead to chlorosis and necrosis, mainly due to Na^+ accumulation that interferes with many physiological processes in plants [2].

Injury of salinity stress on plants

Salinity reduces the growth of glycophytes via several quite distinct processes one of which is the accumulation of salt in the shoot, also, salt stress decrease both of osmotic potential and in stomatal conductance in glycophytes. There are various symptoms of harm by salinity stress on plants such as:

1. Produce growth inhibition, accelerated cell senescence and death.
2. Growth inhibition like abscisic acid when transported to guard cells close plant stomata, therefore photosynthesis declines
3. Plant start produce photoinhibition and oxidative stress,
4. Inhibition of cell expansion either directly or indirectly through abscisic acid,

5. Disturb plant nutrition due to excessive sodium in the soil solution around the root surface.

The injurious effect of salinity on plants varying dependent on climatic conditions, plant species and soil conditions [7].

Sodium stress

Glycophytes plants has low-affinity system due to similarity of sodium and potassium ions nature, sodium has a more harmful effect on glycophytes plants, therefore, under sodium stress, it is very important for plants to use both low- and high-affinity systems for potassium uptake to maintain proper potassium nutrition, in the same time reduce the inhibitory effects of sodium ions on plant growth, glycophytes cannot tolerate high internal sodium in the plant tissue because the main counter ion is chloride [8].

Mechanisms of salt tolerance

Plant tolerance depending on the capability of plants to grow under salinity conditions, there are different plant mechanism to adaptive with salinity stress like toxic ion uptake, ion compartmentation and exclusion, osmotic regulation, CO_2 assimilation, photosynthetic electron transport, chlorophyll content and fluorescence, generation of reactive oxygen species (ROS), and antioxidant defenses [9].

Ion homeostasis and salt tolerance

Preserving ion homeostasis by ion uptake and compartmentalization is one of vital mechanism for glycophytes growth, also, it is an important process for growth under salt stress [10]. Glycophytes tolerate salt concentration in their cytoplasm for limit concentrations, therefore, the high salt concentrations either translocated to the vacuole or stored in older tissues which ultimately are sinensis and died later.

Compatible solute accumulation and osmotic protection

Compatible solute or (osmolytes) are a group of chemically diverse organic compounds include proline [11], glycine betaine [12], and sugar [13], this group of solutes are synthesized and accumulated by different quantity among various plant species. It is uncharged, polar, and soluble in nature and do not interfere with the cellular metabolism even at high concentration, the main roles of these solute are maintaining osmotic balance in the cell through continuous water supply to protect cell structure, as their accumulation is proportional to the external osmolarity [14], under salinity condition the plant cell maintained the concentration of solutes by two ways;

1. Irreversible synthetic of the compatible solutes,
2. Synthesis and dilapidation of the solute in the same time

Antioxidant regulation of salinity tolerance

Abiotic stress in plants, may causes run-off, indirective, or even disturbance of electron transport chains (ETC) in chloroplasts and mitochondria, in this case molecular oxygen (O_2) worked as an electron acceptor, giving rise to the accumulation of reactive oxygen species (ROS) consequently actually harmful for cell integrity [16]. There is a positive correlation between antioxidant activity and plant salinity tolerance, metabolism, substances of antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), glutathione peroxidize (GPX), ascorbate peroxidase (APX), and glutathione reductase (GR) play a critical function in detoxifying ROS induced by salinity stress, also, improving photosynthesis to implement plant growth [17].

Polyamines production

Polyamines (PA) are small, low molecular weight, polycationic aliphatic molecules widely spread throughout the plant kingdom. Polyamines play a varied role in the regular growth and development like regulation of cell proliferation, somatic embryogenesis, differentiation and morphogenesis, dormancy breaking of tubers and seed germination, development of flowers and fruit, and senescence [18]. The plant system includes different polyamines like putrescine (PUT), triamine spermidine (SPD), and tetra-amine spermine (SPM) [11], under salinity stress the polyamines levels increase in plant tissue to increase stress tolerance in plants [19].

When glycophytes plant exposed to salinity stress there are some amino acids concentration decreased in plant tissue like cysteine, arginine, and methionine, wherever, proline increased as a result for salinity stress, the proline accumulation as adopted mechanism for alleviation salinity injuries [15].

Conclusion

Salinity stress reduces plant growth and total crop productivity especially in arid and semiarid region, Glycophytes plants could tolerate salinity for limiting degree by using a various physiological mechanism to avoid salinity injuries like Ion Homeostasis, Compatible Solute accumulation in plant tissue, Antioxidant Regulation, and Polyamines production.

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