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Influence of salinity stress on some characteristics in plants

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Abstract
Stress condition can delay growth and development, reduce productivity, and, in extreme cases cause plant death. Salinity imposes detrimental effects on plant growth through low osmotic potential of soil solution and nutritional imbalance. As a consequence of these primary effects of salt stress, caused by its hyperosmotic effect, secondary stresses, such as oxidative damage. Increasing soil salinity levels strongly influence the essential lipids biosynthesis. In other hand, lipid peroxidation was synchronized with increased of the salinity level which had a relation with plants such as wheat, tomato and purslane was reported. Accumulation of phenolic acids is a well-known symptom of adverse salinity and the production of different classes of phenolic acids produced via the phenylpropanoid system is dependent on the nature of stress exposed to plants.

Keywords: Anti-oxidant, Compatible solutes, Proline, lipid Content

1. Introduction

Abiotic stress

Plants regularly face abiotic stress conditions during growth and development, such as drought, chilling, freezing, high temperatures and salinity. Stress condition can delay growth and development, reduce productivity, and, in extreme cases cause plant death (Krasensky and Jonak, 2012) [17]. High concentrations of soluble salts occur in terrestrial environments or in aquatic environments, which may happen naturally or anthropogenic ally (Larcher, 1995) [18]. The naturally occurring salinization is recognized as primary and the anthropogenic form as secondary (Williams, 1999) [42].

Primary salinization

The primary salinization is a natural process which occurs in regions where there is water deficit, in other words, low rainfall and high evaporation potential, which leads to a progressive increase in the concentration of salts released by weathering or by sea spray that may reach the water bodies as consequence of storms and winds (Suzuki *et al*., 1998; 2002; Roache *et al*., 2006) [35, 34, 30].

Secondary salinization

Unlike primary salinization, secondary salinization results from human activities (Neumann, 1997) [24]. The secondary salinization of water bodies may occur through irrigation of agricultural crops which may leach the accumulated salt in irrigated soils into river and lake waters downstream (Rengasamy, 2006) [29] and, in the specific case of coastal lagoons, through the process of opening sand fences between the sea and the coastal lagoons (Suzuki *et al*.,1998; 2002) [35, 34].

Anti-oxidant system

Salinity imposes detrimental effects on plant growth through low osmotic potential of soil solution and nutritional imbalance (Munns and Tester, 2008) [22]. As a consequence of these primary effects of salt stress, caused by its hyperosmotic effect, secondary stresses, such as oxidative damage, often occur (Zhu, 2001) [47]. In such conditions reactive oxygen species (ROS) are excessively produced in plants, these ROS if not sufficiently reduced, through antioxidant systems cause irreversible intracellular damage through oxidation (Apel and Hirt, 2004) [2]. In general, plants possess an anti-oxidant system including anti-oxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT) and peroxidase (POD) etc. to protect their cells against the damages caused by ROS (Mittler *et al*., 2004) [21].

Compatible solutes

To achieve ion balance in the vacuoles, the cytoplasm accumulates compounds called compatible solutes or osmolytes which do not interfere with normal biochemical reactions (Hasegawa *et al*., 2000; Parida and Das, 2005) [13, 26]. Compatible solutes are neutral molecules, nontoxic, that stabilize proteins and membranes and prevent denaturation at high salt concentrations (Yancey, 2005) [43] and, even at low concentrations, compatible solutes avoid water loss, ion imbalance, reducing intracellular concentration of salts (Burg and Ferraris, 2008) [3]. The compatible solutes accumulated in the cytoplasm of plant cells under salt stress include proline, valine, isoleucine, aspartic acid, pinitol, betaine, glucose, fructose, saccharose, mannitol and inositol (Parida and Das, 2005) [26].

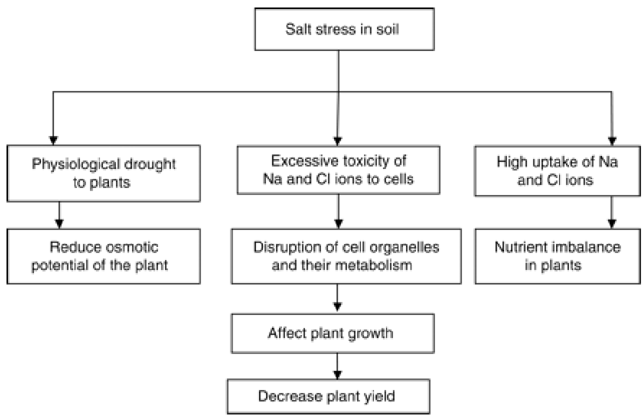

Fig 1: Effects of salt stress on plants

Praline

Praline is an essential amino acid for primary metabolism as a component of proteins and it is mainly synthesized from glutamate (Szabados and Savouré, 2009) [36]. Proline accumulation plays adaptive roles in stress tolerance (Verbruggen and Hermans, 2008) [39], storing carbon and nitrogen (Hare and Cress, 1997) [12].

Influence of salinity stress on lipid Content

The increased production of activated oxygen species (ROS) such as superoxide (O2-), hydrogen peroxide (H2O2), hydroxyl radical (Lehner *et al*., 2008) [19], and singlet oxygen in chloroplasts of plants under salt stress has been described. However, stability of biological membranes has been taken as an effective screening tool to assess salinity stress effects (Abdul Jaleel *et al*., 2007) [1]. For example, Farooq and Azam (2006) [8] reported an increase in cell membrane injury under salt stress in different wheat varieties. It has been suggested that decrease in membrane stability reflects the extent of lipid peroxidation caused by ROS (Heidari and Jamshidi, 2011) [14]. Lipids and proteins are major components in membrane which has main role in plant cell resistance in proportional to environmental stress. Environmental stress due to disordering in cohesions of membrane lipids and proteins (Yordanov *et al*, 2003) [45]. Lipids are among the most prominent constituents of cell membrane which play a fundamental role in cell permeability (Baybordi *et al*, 2010) [4]. Under condition of stress main change will happen in lipids metabolism (Kesri, 2002) [15]. Total lipids content in Canola (Brassica napus L.) with increasing NaCl levels was decreased (Baybordi *et al*, 2010) [4]. Increasing soil salinity levels strongly influence the essential lipids biosynthesis (Solinas and Deiana, 1996) [32]. In other hand, lipid peroxidation was synchronized with increased of the salinity level which had a relation with plants such as Wheat (Hala *et al*, 2005) [11], Tomato (Neumann, 2001) [23] and Purslane (Yazici *et al*, 2007; Rahdari *et al*, 2012) was reported. Mono galactosyl diglyceride (MGDG) is main glycerol lipid in leaf was effect of intensive stress imposing, was reduced that is express of chloroplast membrane destructions (Rahdari *et al*, 2012) [27]. Low unsaturation lipids degree limited the membrane fluidity band restricted permeability to Na and Cl ions (Konova *et al*, 2009) [16]. Phospatidic acid (PA) is a common phospholipids that is a major constituent of cell membranes. PA is the smallest of the phospholipids. They have long been recognized as of importance during germination and senescence, and they appear to have a role in response to stress damage and pathogen attack (Bartels and Sunkar, 2005). PA is lipid signals in plants that normally PA only constitutes a minor proportion of the cellular lipid pool but in responses to stress PA levels can increase significantly (Darwish *et al*, 2009) [6]. PA has been implicated in intracellular signaling that formed in response to salt stress has been suggested to function as a signaling molecule guiding the plants accumulation responses to salt stress. PA can bind and affect the activity of various signaling proteins, including protein kinases and phosphatases (Wang, 2005) [40]. Also, PA has been suggested to regulate the activity of vacuolar pump upon high salt treatment which may help maintain the protein gradient (Zhang *et al*, 2006) [46].

Toxicity

Toxicity in plants results mainly from high concentrations of ions Na+, CI–, (Chinnusamy and Zhu, 2003) [5], although most studies on salinity effect on plants are associated with NaCI excess and few studies have focused on Na2SO4 performance in growth (Renault *et al*., 2001; Stoeva and Kaymakanova, 2008) [28, 33] and in physiology of plants (Pagter *et al*., 2009) [25].

Phenolic acids

Plant cells contain a range of protective and repair systems, which control the metabolism under adverse environmental conditions. Induction of secondary metabolism is one of the regulatory systems of the plants involved in defense system (Dixon and Pavia, 1995) [7]. Accumulation of phenolic acids is a well-known symptom of adverse environmental conditions and the production of different classes of phenolic acids produced via the phenylpropanoid system is dependent on the nature of stress exposed to plants (Weisskopf *et al*., 2006) [41].

Salicylic acid

SA is one of the naturally occurring phenolic acids known as signaling molecule that regulates plant responses to a variety of abiotic stresses such as low and high temperature, salts and oxidative conditions (Gunes *et al*., 2007) [10]. The application of exogenous SA has been shown to protect against several types of stresses such as salinity, temperature, radiation etc. The exogenous application of salicylic acid has been suggested to be an effective approach in improving crop salt tolerance in wheat (Singh and Usha, 2003) [31], barley (Tayeb, 2005) [38], maize (Gautam and Singh, 2009) [9] and tomato (Szepsi *et al*., 2009) [37]. However, the mechanism of SA action in plants is not fully understood.

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