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Mitigation of Salt Stress through Seed Treatment with Glycine Betaine

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Seed germination and seedling growth stages are known to be more sensitive to salt stress. The accumulation of compatible solutes (glycine betaine, proline) is often regarded as a basic strategy for the protection and survival of plants under abiotic stress conditions, including both salinity and oxidative stress.

Introduction

Salinity is a major limiting factor in crop productivity all over the world. In Asia alone, 21.5 million ha are affected, 12 million ha of which are saline and 9.5 million ha are alkaline/sodic. Seeds are the main way through which plants propagate. As seed germination is the beginning of the life cycle of plants. Although salt stress affects all growth stages of a plant, seed germination and seedling growth stages are known to be more sensitive for most plant species and germination has been reported to decline with increasing of salinity levels. Poor germination in saline soils leads to poor crop establishment and hence low productivity. Germination failures on saline soils are often the results of high salt concentrations in the seed planting zone because of upward movement of soil solution and subsequent evaporation at the soil surface. Water is osmotically held in salt solutions. Therefore, the salt concentration completely inhibits germination at higher levels or induces a state of dormancy at low levels, it also reduces imbibition of water because of lowered osmotic potentials of the medium and causes changes in metabolic activity. Salt stress is known to cause osmotic stress, ionic toxicity, oxidative stress and nutritional imbalance in plants. Effect of salt stress includes decreased germination and seedling growth (Ahmad *et al.*, 2010; Ashraf, 2010). For the maintenance of high yield of crops under salt stressed conditions, various research tools are being tried to counteract the effects of salinity. It has been argued that exogenous GlyBet application could be a promising way to directly maintain and enhance the growth and yield in monocot crops such as rice (Farooq *et al.*, 2008), wheat (Ma *et al.*, 2006) and maize (Anjum *et al.*, 2011). Seed priming treatments are simply applied practices that can reduce the effects of salinity with small inputs of capital and energy. Many such seed priming or invigoration treatments are being used to improve the rate and speed of germination under stressed conditions.

Effect of Glycine Betaine

Glycine betaine (GB) acts as a number of quaternary ammonium compounds "Betains" and tertiary sulphonium compounds. In addition, betaine is considered to be involved in scavenging free radicals and in protecting enzymes in addition to their well-established roles as a simple osmolyte. It is reported that betaine act as enzyme protectants against abiotic stresses and protect higher plants against salt/osmotic stresses by stabilizing many functional units such as complex II electron transport, membranes and proteins and enzymes such as RUBISCO. Moreover, exogenous betaine improves stress tolerance by preventing photo inhibition and reducing oxidation of lipid membranes in a wide variety of accumulator/non-accumulator plants. The generation of ROS could be limited or scavenged by a Glycine betaine. Priming of seeds with GB significantly enhanced the activities of catalase (CAT), peroxidase (POD), superoxide dismutase (SOD) and proline content and reduced the malondialdehyde (MDA) accumulation and electrolyte leakage under the salt stress condition. Cotton yield was increased by 18 to 22% by the seed treatment @ 5 and 7.5%, respectively. In a saline soil, germination percentage and seedling dry matter production increased by 64 and 68%, respectively, in response to 5% seed treatment using glycine betaine. Pepper seeds treated with 10 mM glyciebetaine (GB), an organic osmolyte accumulates in variety of plants in response to abiotic stress, for 24 h in darkness improved germination and synchrony of germination under salt stress. Glycine betaine has been postulated to act as a non-toxic cytoplasmic osmoticum and to protect enzymes and membranes from debilitating ionic and dehydrating effects of salt. Treatment of seed resulted in stronger stems and roots, improved branching, earlier flowering, and greater number of squares or bolls. Glycine betaine had activity similar to cytokinins. GB may have a role in Na^+/K^+ discrimination, which substantially or partially contributes to plant salt tolerance. GB application may lead to increase free amino acids especially proline in the water stressed wheat plants and consequently increased the soluble nitrogen as well as total-N.

Conclusion

It can be concluded that the seeds treated with glycine betaine can increase the seed germination (%), seedling vigor index and biomass under salt stress conditions.

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