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Silicon improves seed germination and alleviates drought stress in lentil crops by regulating osmolytes, hydrolytic enzymes and antioxidant defense system

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Abstract

Silicon (Si) has been widely reported to have beneficial effect on mitigating drought stress in plants. However, the effect of Si on seed germination under drought conditions is still poorly understood. This research was carried out to ascertain the role of Si to abate polyethylene glycol-6000 mediated drought stress on seed germination and seedling growth of lentil. Results showed that drought stress significantly decreased the seed germination traits and increased the concentration of osmolytes (proline, glycine betaine and soluble sugars), reactive oxygen species (hydrogen peroxide and superoxide anion) and lipid peroxides in lentil seedlings. The activities of hydrolytic enzymes and antioxidant enzymes increased significantly under osmotic stress. The application of Si significantly enhanced the plants ability to withstand drought stress conditions through increased Si content, improved antioxidants, hydrolytic enzymes activity, decreased concentration of osmolytes and reactive oxygen species. Multivariate data analysis showed statistically significant correlations among the drought-tolerance traits, whereas cluster analysis categorised the genotypes into distinct groups based on their drought-tolerance levels and improvements in expression of traits due to Si application. Thus, these results showed that Si supplementation of lentil was effective in alleviating the detrimental effects of drought stress on seed germination and increased seedling vigour.

Keywords: silicon; lentil; drought stress; proline; superoxide anion; hydrogen peroxide.

1. Introduction

Lentil (*Lens culinaris* Medik.) is the most ancient cultivated crop among legumes and an important source of protein, minerals and vitamins for the human diet (Yadav et al. 2007). Lentil is classified as a silicon (Si) excluder and is moderately tolerant to drought stress. Even though lentil is a moderately drought-tolerant crop and can grow in reduced water supply, plant productivity can decrease from 6-54 % under a range of drought stress conditions (Siddique et al. 1999). Severe water stress can lead to total crop failure, especially in semi-arid regions, where they are commonly exposed to intermittent or terminal drought stress conditions. Lentil is highly sensitive to drought stress at key growth stages, such as seedling, flowering and grain filling (Shrestha et al. 2006). With the forecast of increased water scarcity in near future, drought stress will remain a major threat to global lentil production. Breeding for drought-tolerance remains challenging due to the variation in climatic conditions and multigenic origin of the adaptive responses of lentil plants to drought stress