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Phenological application of selenium differentially improves growth, oxidative defense and ion homeostasis in maize under salinity stress

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Abstract

The underlying mechanism of selenium (Se) mediating plant salt tolerance is not well understood and information on how plant growth and development is regulated by phenological Se application (20 and 40 mg/L) under salinity stress is scarce. In present study, we have appraised the impact of phenological Se application on growth, antioxidant defense system and ionic imbalance in maize under salinity. Salinity (12 dS m^{-1}) reduced growth, concentration of chlorophyll and K^+ in root and leaf. Contrarily, salinity increased toxic Na^+, malondialdehyde (MDA) and H_2O_2 concentration that resulted in oxidative damage. Lower level of Se application (20 mg/L) increased growth and chlorophyll by reducing oxidative damage due to high cell concentrations of MDA and H_2O_2. Se reduced endogenous levels of H_2O_2 and MDA under salinity. Moreover, Se regulated antioxidant defense system by increasing the activities of antioxidant enzymes (SOD, POD and CAT) and influenced the concentrations of non-enzymatic antioxidants (phenolics and flavonoids). Se-induced better antioxidant system protected plants from oxidative damage. We have also recorded substantial increase in K^+ and decrease in Na^+ concentration in plants treated with 20 mg/L Se under salinity stress. The impact of Se on plant growth and development is linked with the growth stage of exogenous application. Foliar Se at reproductive and both vegetative and reproductive stages improved salinity tolerance in maize compared with vegetative stage.

Keywords: Selenium; ion toxicity, NaCl salinity, maize, antioxidant defense system, different growth stages.

Abbreviations: MDA, Malondialdehyde; H_2O_2, hydrogen peroxide; SOD, superoxide dismutase; POD, peroxidase; CAT, catalase

1. Introduction

Salinity suppresses plant growth and development largely through ionic toxicity and osmotic stress (Jiang et al., 2017; Zhu, 2003). Osmotic stress imposes negative impact on stomatal aperture and decreases photosynthesis (Munns and Tester, 2008). Therefore, growth inhibition in plants is attributed to limited photosynthesis under salinity (Chaves et al., 2009; Diao et al., 2014; Jiang et al., 2016; Jiang et al., 2012). Salt-induced limited photosynthesis could also be