

ABSTRACT

Citrulline (CITR) is a strong osmolyte and hydroxyl radical scavenger. However, no previous study has reported the ameliorative role of CITR under salinity stress. We found a significant decrease in growth, chlorophyll content, SPAD value, photosynthesis, leaf relative water content, and nutrient acquisition in sunflower plants exposed to salinity (15 dS m⁻¹). Salinity caused substantial oxidative damage through elevating the levels of superoxide radicals (O₂^{•-}), hydrogen peroxide (H₂O₂), hydroxyl radicals (·OH), leaf relative membrane permeability, malondialdehyde (MDA) and activity of lipoxygenase (LOX). Plants subjected to salinity manifested a higher buildup of methylglyoxal (MG), further exacerbating the cellular damage. However, CITR seed priming (1, 2, and 3 mM) partially relieved the negative repercussions of salinity by promoting the activities of antioxidant enzymes and levels of non-enzymatic antioxidants. Consequently, plants raised from CITR-primed seeds suffered less from oxidative damage and exhibited lower generation of O₂^{•-}, H₂O₂, ·OH, MG, MDA, and activity of LOX. Plants under CITR supplementation exhibited higher chlorophyll content and improved efficiency of photosystem II as evidenced by higher values of maximum efficiency of photosystem-II (Fv/Fm), fraction of open PSII centers (qL), and photochemical quenching coefficient (qP). Citrulline priming enhanced plant resilience under salinity by improving hormonal balance, promoting polyamine accumulation, and sustaining photosynthetic performance. CITR bettered osmotic regulation through increased accumulation of osmolytes such as proline, glycine betaine, and total soluble sugars. Citrulline improved nutrient acquisition and diminished excess Na buildup, preventing specific ion toxicity and osmotic stress.