The physiological, biochemical, and molecular modifications under freezing stress

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Abstract

This experiment was carried out to evaluate the underlying mechanisms of chickpea genotypes (MCC797; cold-tolerant and MCC505; cold-sensitive) responses to freezing temperatures (-3, -6, -9, -12). The increment of leaf malondialdehyde, H2O2, and electrolyte leakage due to freezing stress was greater in the cold-sensitive genotype. The plant survival was also dramatically decreased in the cold-sensitive genotype exposed to freezing stress (20% at -12), while it remained constant (100%) in the cold-tolerant genotype. The fv'/fm' and fq'/fm' was increased sooner during the recovery period in the cold-tolerant (24 h after stress) compare to the cold-sensitive genotype (48 h after stress). Proline and enzymatic antioxidants activity, including APX, CAT, POD, and SOD, were increased more rapidly in the cold-tolerant genotype. The relative gene expression of catalase (cat), peroxidase (pod), and proline were also more stimulated in the cold-tolerant genotype. Freezing temperatures increased the expression of cat, pod, and proline on average by 4, 3, and 6 folds, respectively, in the cold-sensitive, while their upregulation was 16, 13, and 16 folds, respectively, in the cold-tolerant genotype. The greater gene expression and, consequently, the higher antioxidant content of leaves led to lower lipid peroxidation after the cold adaptation in the cold-tolerant genotype.

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