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ORIGINAL ARTICLE

Overexpression of *AtDREB1* and *BcZAT12* genes confers drought tolerance by reducing oxidative stress in double transgenic tomato (*Solanum lycopersicum* L.)

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Abstract

Key message **Double transgenic tomato developed by *AtDREB1A* and *BcZAT12* genes pyramiding showed significant drought tolerance by reducing oxidative stress with enhanced yield.**

Abstract Although a large number of efforts have been made by different researchers to develop abiotic stress tolerance tomato for improving yield using single gene, however, no reports are available which targets *AtDREB1* and *BcZAT12* genes together. Hence, in the present study, double transgenic plants were developed using *AtDREB1* and *BcZAT12* genes to improve yield potential with better drought tolerance. Double transgenic (DZ1–DZ5) tomato lines showed enhanced drought tolerance than their counterpart non-transgenic and single transgenic plants at 0, 07, 14, and 21 days of water deficit, respectively. Double transgenic plants showed increased activity of antioxidant enzymes, like catalase (CAT), superoxide dismutase (SOD), glutathione reductase (GR), ascorbate peroxidase (APX), dehydroascorbate reductase (DHAR), monodehydroascorbate reductase (MDHAR) and guaiacol peroxidase (POD), and accumulation of non-enzymatic antioxidants like ascorbic acid, glutathione as compared to non-transgenic and single transgenic. Additionally, the transcript analysis of antioxidant enzymes revealed the increased level of gene expression in double transgenic tomato lines. Developed double-transgenic tomato plants co-over-expressing both genes exhibited more enzymatic and non-enzymatic anti-oxidative activities as compared to the non-transgenic and single transgenic control, respectively. This is the preliminary report in tomato, which forms the basis for a multigene transgenic approach to cope with drought stress.

Keywords *AtDREB1A · BcZAT12 · Co-overexpression · Drought · Gene pyramiding · Double transgenics · Solanum lycopersicum*

Introduction

In agriculture, a plant generally faces water scarcity due to abiotic stresses like drought, cold, and salinity. The inadequate water availability adversely affects plant growth, development, yield and crops quality which depends on the duration, degree of water deficit, and crop stage (Krishna et al. 2019, 2021; Karkute et al. 2019). Throughout the world, about 20% of agricultural land is under irrigation, of which 14.51% is supported by good irrigation (FAO 2012) while the remaining is rainfed, hence, frequently prone to drought/ water-deficit stress. The drought stress is considered as the most destructive stress among abiotic stresses which alters plants physiological activity primarily through disturbing plant–water relationship and by the generation of reactive oxygen species (ROS) Sharma et al. (2012),

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