PB I -1

Improving Stress Tolerance by Regulon Engineering of ABA-Responsive Genes

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Harsh environmental conditions, such as drought, extreme temperature and high salinity, are major limiting factors of crop productivity worldwide. Plants have the ability to adapt to the abiotic stress conditions, and the adaptive process is largely controlled by the phytohormone abscissic acid (ABA). We are interested in the identification of regulatory components of the ABA-dependent adaptive stress responses. In particular, our focus has been on the transcriptional regulators, which we isolated and designated as ABF1-ABF4 (Abscissic Acid-Responsive Element Binding Factors 1-4).

We investigated the function of ABFs in ABA and stress responses by analyzing ABF overexpression lines and their mutants. Our results indicate that ABFs display overlapping, but distinct overexpression phenotypes. ABF1 overexpression did not display significant phenotypic changes. ABF2 plays both positive and negative regulatory role in ABA/stress response depending on the developmental stage, and salt, heat and oxidative stress tolerance are enhanced by its overexpression. ABF3, on the other hand, is a positive regulator of ABA/stress response and promotes multiple stress tolerance, i.e., tolerance to drought, chilling, freezing, heat and oxidative stresses. ABF4 is also a positive regulator and enhances multiple stress tolerance (i.e., drought, freezing and oxidative stress tolerance). However, unlike ABF3, ABF4 overexpression causes severe dwarfism.

The mode of gene regulation by ABA is highly conserved among plant species. The same *cis*-regulatory elements (i.e., ABREs) function in both dicot and monocot plants, and ABF homlogs have also been reported in major crop species. The high degree of conservation of regulatory elements suggests that ABFs would function in a wide variety of plant species. We generated transgenic lines of several crop species to test the possibility. Preliminary analysis of the transgenic plants indicates that ABFs promote the stress tolerance of both vegetable and monocot crop plants.