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Roc10, a Rice HD-Zip transcription factor gene, modulates lignin biosynthesis for drought tolerance

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Abstract

Drought, a common environmental constraint, induces a range of physiological, biochemical and molecular changes in plants, and can cause severe reductions in crop yield. Consequently, understanding the molecular mechanisms of drought tolerance is an important step towards crop biotechnology. Here, we report that the rice (*Oryza sativa*) homeodomain-leucine zipper class IV transcription factor gene, *Rice outermost cell-specific gene 10* (*Roc10*), enhances drought tolerance and grain yield by increasing lignin accumulation in ground tissues. Overexpression of *Roc10* in rice significantly increased drought tolerance at the vegetative stages of growth and promoted both more effective photosynthesis and a reduction in water loss rate, compared with non-transgenic controls or RNAi transgenic plants. Importantly, *Roc10* overexpressing plants had a higher drought tolerance at the reproductive stage of growth and a higher grain yield compared with the controls under field-drought conditions. *Roc10* is mainly expressed in outer cell layers including the epidermis and the vasculature of the shoots, which coincides with areas of cell wall lignification. *Roc10* overexpression elevated the expression levels of lignin biosynthetic genes in shoots, with a concomitant increase in the accumulation of lignin, while the overexpression and RNAi lines showed opposite patterns of lignin accumulation. We identified downstream target genes of *Roc10* by performing RNA-seq and chromatin immunoprecipitation (ChIP)-seq analyses of shoot tissues. Roc10 was found to directly bind to the promoter of *PEROXIDASEN/PEROXIDASE38*, a key gene in lignin biosynthesis. Together, our findings suggest that *Roc10* confers drought stress tolerance by promoting lignin biosynthesis in ground tissues.

Keywords: Drought tolerance, Transgenic rice, Lignin biosynthesis, HD-Zip transcription factor.

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