

白桦 bZIP53 转录因子抗旱机制解析

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摘要:【目的】目前, 全球范围内干旱出现的频率、持续时间以及空间范围呈现出不断增加的趋势, 干旱已经成为限制全球植物生长的主要因素之一。鉴定、解析抗旱相关 *BpbZIP53* 基因的功能将为深入理解白桦应对干旱胁迫的分子机制提供重要资料, 本文以期为白桦抗旱遗传改良提供优良资源及理论基础。【方法】本研究利用稳定转化的过表达、敲除表达 *BpbZIP53* 转基因白桦, 观察转基因和对照株系在干旱胁迫处理前后的长势, 测定其抗旱生理指标, 比较不同株系对于干旱胁迫的耐受能力。通过 RNA-seq 寻找下游靶基因, 并通过 ChIP-PCR、EMSA、Y1H、dual-LUC 方法进行鉴定。【结果】基于前期构建的白桦干旱胁迫多层次调控网络, 从中筛选到一个顶层调控转录因子 BpbZIP53, 该基因编码区为 438 bp, 共编码 145 个氨基酸。转基因白桦表型分析结果显示, 干旱胁迫条件下, 过表达 BpbZIP53 转基因白桦的生长优于对照, 更优于敲除株系。过表达 BpbZIP53 株系的相对含水量高于对照, 叶片失水率显著低于对照, MDA 和 H₂O₂ 含量明显低于对照, 而 SOD、POD、CAT 等抗氧化酶活性高于对照, 而敲除株系相反。BpWRKY6 和 BpMYB14 为 BpbZIP53 的下游靶基因, BpbZIP53 通过结合其启动子上的 ABRE 元件, 从而激活 BpWRKY6 和 BpMYB14 的转录。【结论】过表达 BpbZIP53 可通过调节 BpWRKY6 和 BpMYB14 的表达, 从而增加抗氧化酶活性来降低过氧化物质的积累, 从而提高转基因白桦对于干旱胁迫的耐受性。

Analysis of drought resistance mechanism of bZIP53 transcription factor in *Betula platyphylla*

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Abstract: 【Objective】 At present, the frequency, duration, and spatial scope of drought occurrence on a global scale are showing an increasing trend, and drought has become one of the main factors limiting global plant growth. Identifying and analyzing the function of the *BpbZIP53* gene related to drought resistance will provide important data for a deeper understanding of the molecular mechanism of response to drought stress for *Betula platyphylla*. This study aims to provide excellent resources and theoretical basis for genetic improvement of birch's drought resistance. 【Method】 This study used stable overexpression and knockout of *BpbZIP53* transgenic birch to observe the growth of transgenic and control before and after drought stress, measure their drought resistance physiological indicators, and compare the tolerance of different strains to drought stress. Search for target genes through RNA-seq and identify them using ChIP-PCR, EMSA, Y1H, and dual-LUC methods. 【Result】 Based on the multi-layer regulatory network of drought stress in birch constructed in the early stage, a top-level regulatory transcription factor BpbZIP53 was screened out, with a coding region of 438 bp and a total of 145 amino acids encoded. The phenotypic results showed that under drought stress, the growth of overexpressing *BpbZIP53*

transgenic birch was better than the control and even better than the knockout strain. The relative water content of the overexpressing *BpbZIP53* strain was higher than that of the control, and the leaf water loss rate was significantly lower than that of the control. The MDA and H_2O_2 contents were significantly lower than those of the control, while the activities of antioxidant enzymes such as SOD, POD, CAT were higher than those of the control, while the opposite was true for the knockout strain. *BpWRKY6* and *BpMYB14* were downstream target genes of *BpbZIP53*. *BpbZIP53* activates the transcription of *BpWRKY6* and *BpMYB14* by binding to ABRE elements on their promoters.

【Conclusion】 Overexpression of *BpbZIP53* can regulate the expression of *BpWRKY6* and *BpMYB14*, thereby increasing antioxidant enzyme activity and reducing the accumulation of peroxides, thereby improving the tolerance of transgenic birch to drought stress.