

CsWOX11 Interacts with CsARF6/8 and CsLBD16/18 to Coordinate Lateral Root Development and Drought Responses in Citrus

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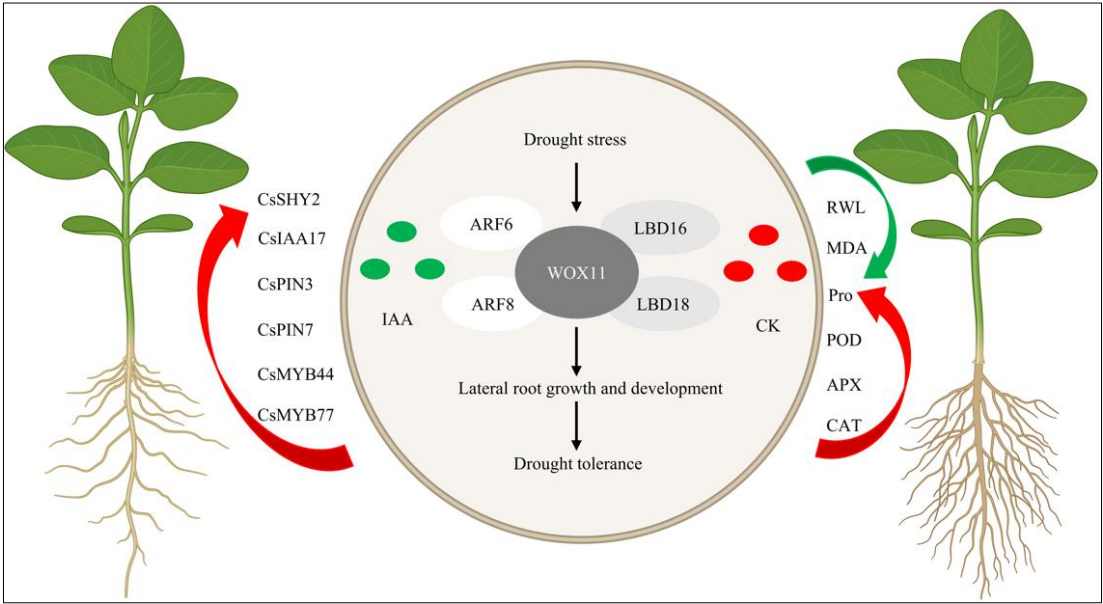
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Abstract

Lateral roots are central to drought adaptation, yet the molecular modules coordinating lateral root development and drought tolerance in perennial fruit trees remain poorly understood. Here, we identified a WOX–ARF/LBD regulatory module in citrus. Yeast two-hybrid, bimolecular fluorescence complementation, and luciferase complementation imaging assays demonstrated that CsWOX11 physically interacts with CsARF6/8 and CsLBD16/18. Overexpression of CsARF6/8 and CsLBD16/18 in transgenic hairy roots significantly increased lateral root number, length, and density, whereas knockout lines showed the opposite phenotypes. Overexpression elevated auxin but reduced cytokinin contents and upregulated root developmental genes, including CsSHY2, CsPIN3/7, and CsMYB44/77. Under PEG-induced osmotic stress, knockout of CsWOX11, CsARF6/8, or CsLBD16/18 increased relative water loss and malondialdehyde accumulation while decreasing proline content and APX, POD, and CAT activities, indicating impaired osmotic adjustment and ROS scavenging. These results establish the CsWOX11–CsARF6/8–CsLBD16/18 module as a positive regulator of lateral root growth and drought tolerance, providing candidate targets for breeding drought-resistant citrus cultivars.

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Innovative Description: Discovery of the citrus "WOX-ARF/LBD" module: CsWOX11 interacts with CsARF6/8 and CsLBD16/18 to enhance lateral root growth and drought tolerance.