

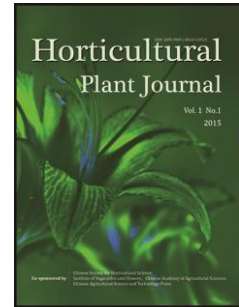
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# Functional Characterization of the Apple RING E3 Ligase MdMIEL1 in Transgenic *Arabidopsis*

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## Abstract

E3 ubiquitin ligases are involved in various physiological processes, and they play pivotal roles in growth and development. In this study, we identified a previously unknown gene in the apple fruit (*Malus × domestica*) and named it *MdMIEL1*. The *MdMIEL1* gene encoded a protein that contained a zinc-finger domain at its N-terminus and a RING-finger motif at its C-terminus. To investigate *MdMIEL1* functions, we generated transgenic *Arabidopsis* lines expressing the *MdMIEL1* gene under the control of the *Cauliflower mosaic virus* 35S promoter. Interestingly, ectopic expression of *MdMIEL1* in *Arabidopsis* produced multiple phenotypes, including early germination, early flowering and a lateral root number increase relative to wild-type plants. Further analysis indicated that *MdMIEL1* regulated lateral root initiation by increasing auxin accumulation in the roots. In a word, these results suggest that *MdMIEL1* as a novel RING-finger ubiquitin ligase influences plant growth and development and highlight that *MdMIEL1* regulates lateral root growth.

**Keywords:** apple; E3 ubiquitin ligases; *MdMIEL1*; RING-finger motif; root development

## 1. Introduction

Ubiquitin-proteasome system (UPS)-mediated proteolysis plays a vital role in regulating numerous biological processes, and the ubiquitin-proteasome complex affects plant growth and development by targeting proteins for degradation (Serino and Xie, 2013; Zhang et al., 2013). Proteolysis involves a succession of catalyzed reactions with the goal of attaching ubiquitin motifs to target proteins. The three enzyme types involved in ubiquitination include ubiquitin activating enzymes (E1s), ubiquitin conjugating enzymes (E2s) and ubiquitin ligases (E3s) (Glickman and Adir, 2004; Smalle and Vierstra, 2004). The E3 ubiquitin ligase is an essential component in this process, and it determines the specificity of a protein substrate (Stone and Callis, 2007). The E3 ubiquitin ligase family of proteins includes multiple enzyme types, such as HECT-type, RING-type, U-box type and the SCF complex, that play important roles in plant growth and developmental processes and are in responding to environmental stress (Stone and Callis, 2007; Guo et al., 2013). The RING family is the largest group of E3 ubiquitin ligases, and they are typified by a RING domain.

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