Arabidopsis SMO2 regulates seed germination and ABA response

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Arabidopsis SMALL ORGAN2 (SMO2) encodes a functional homologue of yeast TRM112, and disruption of SMO2 results in a defect in progression of cell division and organ growth. Here, we show that SMO2 mediates the abscisic acid (ABA) response during seed germination. smo2 exhibits an obvious delay of seed germination and is hypersensitive to abscisic acid (ABA), while transgenic seeds overexpressing SMO2 are hyposensitive to ABA. Given that SMO2 is required for proper cell division in root apex, our observation suggests that SMO2-regulated progression of cell division is involved in ABA response during seed germination.

Seed germination is Delayed in smo2

In addition to its smaller organs, Arabidopsis smo2 knockout mutant was found to exhibit obviously delayed seed germination compared to WT. To investigate the effect of SMO2 on seed germination, we compared germinating time between wild type (WT) and smo2 seeds, by examining the percentage of germinated seeds after stratification. As shown in Figure 1, WT seeds began to germinate at about 16 h and all the seeds completed germination at 24 h after stratification, however, smo2 seeds began to germinate at 20 h and almost all the seeds germinated at 48 h after stratification. This finding demonstrates that disruption of SMO2 delays seed germination. Previous studies revealed that disturbance of some cell cycle regulators, such as CYCD4;1 or CYCD1;1, leads to a delay of seed germination due to the retardation of the onset of cell proliferation. Given that mutation of SMO2 impedes progression of cell division in root apical meristem, our observation suggests that the delay of seed germination is associated with ABA and its signaling. Recent studies also reveal that progression of cell division is inhibited by ABA during seeds germination of maize (Zea mays L.) and coffee (Coffeea arabica ‘Rubi’). Our previous work demonstrates that Arabidopsis SMO2 modulates progression of cell division during organ growth. In this report, we further describe that SMO2 affects ABA response during seed germination. Our finding suggests that the role of ABA in seed germination may, at least in part, involve the progression of cell division.

Key words: SMO2, seed germination, cell division, ABA response
germination in smo2 is related to the defect in cell division progression.

**Mutation or Overexpression of SMO2 Alters ABA Sensitivity**

ABA is a classical plant hormone that has been defined to negatively regulate seed germination.⁵,⁶ Because seed germination was delayed in smo2, we therefore speculated whether the role of SMO2 in seed germination is related to ABA response. To test this, the seeds of WT, smo2 and two independent 35S-SMO2 transgenic lines (SMO2-OE 4-4 and SMO2-OE 13-3) were germinated on the media supplemented with different concentrations of ABA. As shown in Figure 2A–C, compared to WT, smo2 showed hypersensitive to ABA, and conversely the SMO2-OEs exhibited apparently less sensitive to ABA. Cotyledon greening assay showed that, when seeds were germinated on the medium with 0.2 µM ABA, 64% of WT seedlings became greening, whereas greening seedlings in smo2 and SMO2-OEs were 27% and 100% (Fig. 2D), respectively, indicating that knockout or ectopic expression of SMO2 affects ABA sensitivity during seeds germination.

**Conclusions**

Our previous work revealed that SMO2 is required for proper cell cycle progression. Here, we further show that SMO2 affects seed germination and ABA response. These observations strongly suggest that the ABA-regulated seed germination is associated with progression of cell division. Similar cell cycle progression defects and altered
ABA sensitivity have been reported in Arabidopsis abo4-1 mutant, which contains a mutation in the DNA polymerase ε. In addition, ABA have been found to have inhibitory role in G1-S progression in cell cycle, and smo2 has the defect in G1-M phase and possible G1-S progression. Therefore, it is likely that proper cell division progression is, at least in part, required for ABA-regulated seed germination.

References