SOB3/AHL29 Regulates Seed Size and Hypocotyl Elongation in Plants

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Seed shape and size are important agronomic traits because they can affect yield, ease of harvesting, and seedling establishment especially under adverse conditions (e.g. drought, weed and pest pressure). The development of crop varieties that have large seeds and long hypocotyls as seedlings yet maintain normal growth characteristics as adults is challenging for traditional breeding because the regulation of seed/seedling size is a complex and can also be linked to other agronomic traits such as heading date or flowering time.

Based on our previous findings, some of the AHL (AT-Hook Containing, Nuclear Localized) genes play crucial roles in determining seed size and hypocotyl length in Arabidopsis thaliana, a model brassica plant. When we express particular mutant forms in two of the AHL genes AHL29/SOB3 (Suppressor of Phytore tube B-4 #3) and AHL27/ESC (ESCAROLA) the resulting transgenic Arabidopsis thaliana plants have normal adult growth that give rise to larger seeds and seedlings with longer hypocotyls than the wild type. Arabidopsis thaliana and Camelina sativa are from same family (Brassicas) and both have similar genomes. Camelina sativa is an emerging oilseed crop in dryland cropping systems. We have also seen similar results when generating transgenic Camelina sativa overexpressing the same mutant forms of AHL29/SOB3 and AHL27/ESC.

Based on our preliminary results, we proposed: (1) to compare seed size of different mutations of Arabidopsis thaliana AHL29/SOB3 and AHL27/ESC to identify the specific mutations that confer bigger seeds and longer hypocotyls than the wild type. Arabidopsis thaliana and Camelina sativa are from same family (Brassicas) and both have similar genomes. Camelina sativa is an emerging oilseed crop in dryland cropping systems. We have also seen similar results when generating transgenic Camelina sativa overexpressing the same mutant forms of AHL29/SOB3 and AHL27/ESC.

In this study we have generated transgenic lines of Arabidopsis thaliana overexpressing different AHL mutations. We have then generated transgenic Camelina sativa plants overexpressing similar mutated Arabidopsis thaliana genes as well as similar genes from Camelina sativa (SOB3-6-like). Seedlings hypocotyl length, seed size and seed weight were then measured and analyzed using the appropriate software.
Our results show that transgenic plants expressing a particular mutation in SOB3 (SOB3-6), as well as a similar mutation in ESC (ESC-11), confer bigger seeds and taller seedlings than non-transgenic lines in Arabidopsis thaliana. The SOB3-6 mutation can make seeds that are 50% bigger and seedlings that are twice as tall as non-transgenic plants. In addition, the ESC-11 mutation can make seeds that are ~25% bigger and seedling that are 50% taller than non-transgenic plants. Other mutations we have created in SOB3 can make seedlings slightly taller but cannot make seeds any bigger than wild type. When we overexpressed the Arabidopsis thaliana SOB3-6 mutation in Camelina sativa, seeds can be 50% bigger and seedlings can be 50% taller than non-transgenic plants. When we overexpressed the Camelina sativa SOB3-6-like mutation in Camelina sativa, seeds can be 50% bigger and seedlings can be ~65% taller than non-transgenic plants. Taken together, SOB3 modulates seed size and hypocotyl length in Arabidopsis thaliana and Camelina sativa which, may lead to better seedling establishment and increased yield in dryland cropping system.

Figure 2. Picture is of transgenic Camelina sativa seeds expressing the Arabidopsis thaliana SOB3-6 mutation compared to non-transgenic wildtype plants (Wt).