The role of light and hormones in seed germination under environmental stress

Environmental factors such as light, temperature, water and gravity have major effects on plant development. In addition, hormones within the plant bring about developmental changes during the plant life cycle. Extensive crosstalk exists between environmental and hormone signaling. The molecular basis of these interactions is beginning to be revealed. Our work focuses on interactions between light and the plant hormone abscisic acid (ABA) in the model plant *Arabidopsis thaliana* (mouse eared cress).

When a seed germinates, it can follow two different developmental strategies depending on the availability of light, namely photomorphogenesis (light growth) or skotomorphogenesis (dark growth). In light, a seedling will undergo photomorphogenesis, which is characterized by a short embryonic stem (hypocotyl), expanded embryonic leaves (cotyledons). In contrast, in darkness a seedling will have long hypocotyls and folded cotyledons and is called etiolated. Genetic screens have identified two different types of light signaling mutants, light insensitive mutants, that are blind to light, and constitutively photomorphogenic mutants that look like light grown seedlings even in the dark. *de-etiolated 1 (det1)* mutants are constitutively photomorphogenic thus normally DET1 protein is a repressor of light growth. On the other hand, LONG HYPOCOTYL 5 (HY5) promotes light growth. It has been shown that *det1* mutants have increased levels of HY5, resulting in their constitutively photomorphogenic appearance.

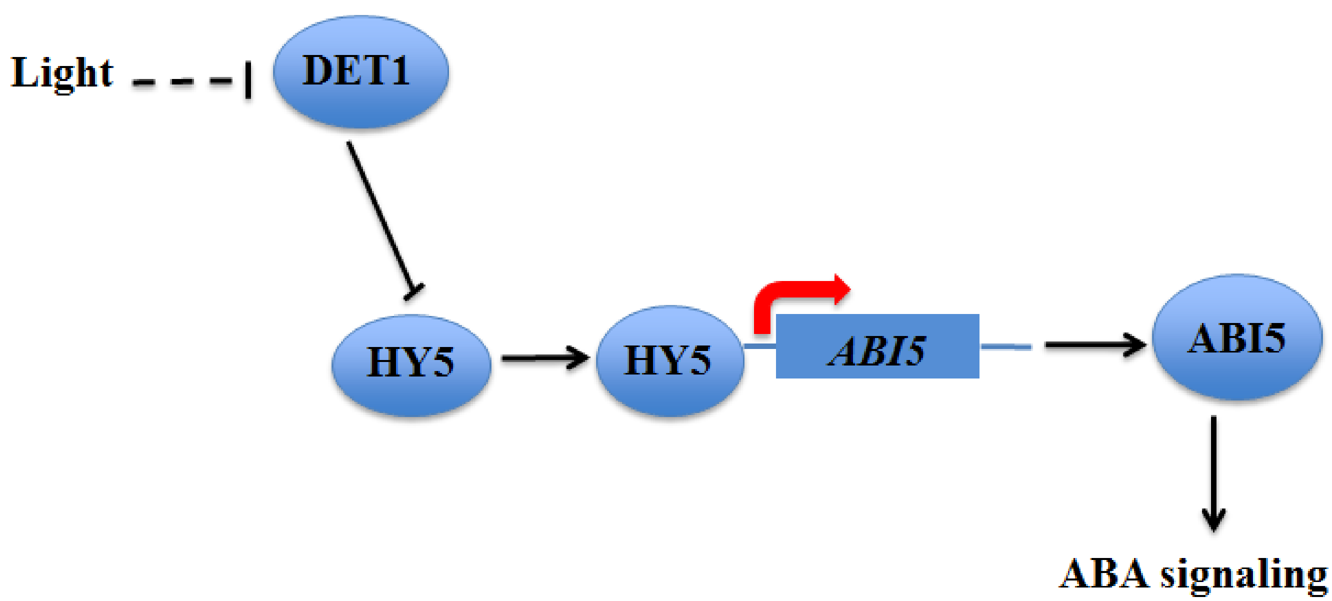

Fig. 1 Model for basis of *det1* ABA sensitive germination. In *det1* mutants there is an excess of

HY5. HY5 increases ABI5 levels resulting in increased ABA signaling and reduced germination.

Due to their immobile nature, plants cannot avoid stress conditions in the surrounding environment. The plant hormone abscisic acid (ABA) acts as a messenger during stress signaling and initiates a number of responses to confer stress tolerance, such as inhibiting seed germination and reducing water loss in adult plants to promote dessication tolerance. HY5 has been shown to be a positive regulator of ABA signaling and a key integrator of the light and ABA signaling pathways. Our study aimed to investigate the role of light signaling component DET1 in ABA and light signal integration. We examined ABA responses in *det1* mutants and found that seed germination in *det1* is hypersensitive to ABA. Next we generated double mutants with *det1* and intermediate genes in the ABA pathway, namely HY5 and ABSCISIC ACID INSENSITIVE 5 (ABI5), in order to assess which genes are required for *det1* ABA sensitive germination. We hypothesized that in *det1* mutants excess HY5 would increase ABI5 levels, resulting in increased ABA signaling and reduced germination. Our results indicate that *HY5* and *ABI5* contribute to *det1* ABA sensitive seed germination, confirming our model (Fig. 1). *det1* mutants do not show sensitivity to ABA at all growth stages however. In fact cotyledon emergence in *det1* exhibits ABA resistance, and neither HY5 nor ABI5 are required for this trait. In addition, *det1* mutants exhibit rapid water loss as adults and this trait does not require any of the intermediate genes examined. Thus the response of *det1* mutants to ABA-mediated stress is complex and varies between tissues and developmental stages. The results of our research provide insight into interactions between ABA and light signaling in plants.

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Publication

Genetic interactions between DET1 and intermediate genes in Arabidopsis ABA signalling.
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Plant Sci. 2015 Oct