

involvement in stress processes. ABA showed stress-dependent biosynthesis, which transported the target cells that enable the plant to cope better with stressful conditions. The widespread occurrence across the entire tree of life suggests an ancient origin of ABA, which plays a vital role in modulating cellular responses to environmental signals, e.g. water-deficient stress (Cuming et al. 2007). However, ABA is the major hormone involved in induction and maintenance of dormancy by pre-harvest sprouting/viviparous mutants in rice (Fang and Chu 2008).

Furthermore, the absence of xanthophylls was associated with reduced ABA content, which in turn correlated with vivipary. Even though, the kernels of VP-8 had a reduced ABA content, xanthophylls were also present. Seedlings of carotenoid-deficient mutants were rescued from viviparous kernels and contained less ABA than wild-type seedlings grown in the same way (Neill et al. 1986). Precocious germination can be induced in soybean seeds after a slow drying treatment, which causes a decrease of its endogenous ABA (Ackerson 1984b); whereas, mid-stage soybean embryos cultured in the absence of ABA exhibit precocious germination. The young embryos undergo normal embryogenesis in the presence of ABA (Ackerson 1984a). The suppression of precocious germination by ABA content derived from the studies of mutants defective in ABA metabolism (Black 1991; McCarty 1995). Also, the exogenously supplied ABA prevented the germination of excised, immature cotton embryos and embryos placed on ABA-free medium exhibited precocious germination/vivipary (Ihle and Dure 1970). Furthermore, ABA-deficient or ABA-insensitive *Arabidopsis* mutants show reduced seed maturation and dormancy (Finch-Savage and Leubner-Metzger 2006; Koornneef et al. 2002; Leon-Kloosterziel et al. 1996). Unlike in *Arabidopsis*, cereal plants and maize embryos from ABA-deficient mutants germinate precociously (vivipary) on the ear (White et al. 2000).

The following ferns have been reported for the presence of ABA. All the ferns are non-viviparous, such as *Anemia phyllitidis* (Cheng and Schraudolf 1974); *Lygodium japonicum* (Yamane et al. 1980); *Cibotium glaucum* and *Dicksonia antarctica* (Yamane et al. 1988); *Marsilea drummondii* (Pilate et al. 1989); *Pteridium esculentum* and *D. antarctica* and a lycophyte (*Selaginella kraussiana*) (Brodrribb and McAdam 2011; McAdam and Brodrribb 2012). The presence of ABA inhibits precocious germination or vivipary in ferns as described by Sakata et al. (2014) and ABA-related genes are summarised in Table 11.2.

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**TABLE 11.2**  
**ABA-Related Genes in Plants**

Function	Genes
ABA metabolism	ABA1/ZEP, ABA4, NCEDs, ABA2, AAO3, ABA3, BG1, CYP707As
ABA transport	ABCG25, ABCG40, AIT
ABA signalling	PYR/PYL/RCARs, Group A PP2C, Subclass III SnR K2, AB13, AB14, AB15, SLAC1
Ca <sup>2+</sup> -dependent factor	CIPK/SnRK3, CDPK, CBL, CaM/CML

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