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The relationship between the emission of volatile isoprenoids and abscisic acid biosynthetic pathway(s) in leaves

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Isoprene (2-methyl-1,3-butadiene) is the biogenic hydrocarbon emitted by plants in highest amount, although its physiological function(s) in plants is (are) still unclear. Isoprene has been hypothesized to have a regulatory role by dissipating excess energy or carbon (Logan et al., 2000), and a protective role under various environmental stress conditions (Sharkey and Singsaas, 1995, Loreto et al., 2001, Loreto and Velikova, 2001). Recently it has also been suggested that isoprene may play a signalling role under stress conditions (Velikova et al., 2005). Isoprene is formed via the chloroplastic 1-deoxy-D-xylulose 5 phosphate/ 2-C-methyl-D-erythritol 4-phosphate (DOXP/MEP) pathway (Lichtenthaler et al. 1997). This is the same pathway forming more complex isoprenoids such as carotenoids. Carotenoids are precursors of abscisic acid (ABA) (Milborrow 2001, Schwartz et al. 2003), but several studies suggested that multiple ABA pools are present in leaves, possibly originating from pathways different than the carotenoid cleavage. Under stress conditions ABA production is not blocked by carotenoid inhibitors (Li and Walton 1987). We explored whether a direct link between isoprene emission and ABA content exists in leaves emitting or non-emitting isoprene, modulating isoprene emission with fosmidomycin, an inhibitor of the DOXP/MEP pathway. (Zeidler et al. 1998). The inhibition of isoprenoid synthesis generally reduces, with a similarly rapid time-course, ABA content in leaves, inducing stomatal aperture. Though the emission of isoprene was completely inhibited upon fosmidomycin feeding through the petioles of detached leaves for short periods

(up to 1 hour), the reduction of leaf ABA content was only partial, generally less than 50%. Neither inhibition of photosynthesis nor reduction in total carotenoid content and changes in xanthophyll de-epoxidation status upon fosmidomycin feeding were found. Our results suggest that at least two pools of ABA are present in leaves and that fosmidomycin only blocks a pool quickly turning-over, explaining the partial association between ABA content and isoprene emission. We suggest that the pool of ABA directly linked to isoprenoid emission actively regulates stomatal closure, and that this regulation may occur also in non-stressed leaves. In isoprene-emitting species, isoprene may be regarded as a proxy of ABA level in leaves, but plants non-emitting isoprene may have as well an ABA pool rapidly formed from the MEP pathway.

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