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Gradients of lipid storage, photosynthesis and plastid differentiation in developing soybean seeds

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Abstract:

This study establishes a topographical framework for functional investigations on the regulation of lipid biosynthesis and its interaction with embryo photosynthesis in developing soybean seed. Structural observations, combined with molecular and functional parameters, revealed the gradual transformation of chloroplasts into storage organelles, starting from inner regions going outwards. This is evidenced by electron microscopy, confocal laser scanning microscopy, *in situ* hybridization and histochemical/biochemical data. As a consequence of plastid differentiation, photosynthesis becomes distributed along a gradient within the developing embryo. Electron transport rate, effective quantum yield and O_2 production rate are maximal in the embryo periphery, as documented by imaging pulse-amplitude-modulated fluorescence and O_2 release via microsensors. The gradual loss of photosynthetic capacity was accompanied by a similarly gradual accumulation of starch and lipids. Non-invasive nuclear magnetic resonance spectroscopy of mature seeds revealed steep gradients in lipid deposition, with the highest concentrations in inner regions. The inverse relationship between photosynthesis and lipid biosynthesis argues against a direct metabolic involvement of photosynthesis in lipid biosynthesis during the late storage stage, but points to a role for photosynthetic oxygen release. This hypothesis is verified in a companion paper.

Key-words: Embryo photosynthesis, microsensor, non-invasive NMR, oil biosynthesis, plastid differentiation, pulse-amplitude-modulated (PAM) fluorescence, seed development