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Editorial Open Access

Sugar Partitioning and Sink-Source Modification in Plants

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Editorial

Solar energy is converted to chemical energy and stored as assimilates through a phenomenon called photosynthesis. Plant leaves function as the principle site of resource acquisition by utilizing the free energy captured via photosynthesis for the reductive assimilation of oxidized forms of carbon into carbohydrates. Photosynthetic carbon fixation provides vital energy for metabolism and precursors for all other biosynthetic pathways in the plant. Most of these precursors are required for biosynthesis of amino acids that form the building blocks for many compounds in plants. The regulation of assimilate partitioning in leaves is considered as allocation of carbon between sucrose and starch synthesis, storage, and export, and carbohydrate metabolism [1,2]. Sucrose is the most important metabolite in this system of resource allocation because it is generally the major end product of photosynthetic carbon metabolism and, in most plants it is the predominant form of carbon transported to the heterotrophic tissues [3-5]. Sucrose allocation between tissues is a fundamental process in all multicellular organisms. Indeed, as much as 80% of the carbon acquired in photosynthesis is transported in the plant's vascular system to import-dependent organs [6].

Moreover, in many plants, energy-dependent sucrose accumulation in the phloem generates the high hydrostatic pressure that drives the long-distance flow of resources. The systemic distribution of photosynthate is known as assimilate partitioning, and it is a major determinant of plant growth and productivity [7]. Our understanding of assimilate partitioning has advanced considerably over the last 30 years with the successful biochemical and molecular descriptions of several proteins that participate in this essential process (e.g. [8-11]). The current concept of phloem transport comprises three steps: (i) loading of photosynthates into the sieve element companion cell complex (se-cc complex) of minor veins in exporting leaves, (ii) translocation from source to sink, and (iii) unloading in growing or storing sinks [12].

Active transport by specific carriers across the apoplast, and symplastic transport via plasmodesmata, has been discussed as possible mechanisms for sucrose transport [13]. The transport is active and has been described as a sucrose-proton co-transport with a 1:1 stochiometry [14].

Sink or source regulated modification of sucrose partitioning in plants is speculated to be a good strategy either for enhancing yield performance and improving plant-stress interactions, and for unravelling the biochemical, physiological and molecular mechanisms underlying sucrose partitioning in plants. To this end, modification could be achieved in two ways: (i) external treatments such as leaf girdling by hot wax collars to prevent export of assimilates from the leaves [15] or such as defoliating [16], or (ii), in vivo molecular manipulation [17,18]. In regard to the latter, one of the molecular candidates for increasing or decreasing sink and source strength through intervention with assimilate loading or unloading is sucrose transporters. Another powerful tool for studying sucrose metabolism and sink/source interactions is apoplastic invertase, as it cleaves sucrose into the monosaccharide glucose and fructose [19].

Using sucrose proton co-transporter antisense lines, [13] showed clear evidence for an essential role of the sucrose transporter in phloem loading and assimilate partitioning. The antisense plants strongly support an apoplastic model for phloem loading, in which the sucrose transporter located at the phloem plasma membrane represents the primary route for sugar uptake into the long distance distribution network. Invertase cleaves sucrose into glucose and fructose. A range of studies supports the hypothesis that the primary function of invertases is to supply carbohydrates to the sink tissues [20,21].

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