The Carbohydrate Economy of Horticultural Crops: Introduction to the Colloquium

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The carbohydrate economy of horticultural crops has long interested horticulturists because of the potential for modifying plant carbohydrate allocation in order to increase marketable yields. To improve fruit size, grape producers historically have girdled their vines, and tree fruit producers often cluster or blossom thin. Since most cultural practices that alter carbohydrate allocation are used in tree fruit and vine production, most research into carbohydrates has involved these crops. Now, however, research on other crops is increasing, including investigations on the effects of the environment on

carbohydrate economy, the modeling of carbohydrate flux, and the intricacies of the biochemistry and molecular control of carbohydrate allocation.

Accumulation of carbohydrates in tree fruits is greatly affected by the carbon reserves available (Keller and Loescher, 1989), the formation of adequate canopy (Palmer and Jackson, 1977), light interception, respiratory loss, and assimilate supply from photosynthesis (Amthor, 1989), crop load, and other external factors. Reports by Lakso et al. and Flore and Layne in this colloquium discuss these and other influences for apple and cherry, as well as how the factors may be integrated to understand the whole carbohydrate economy of these orchard trees. Similarly, Goldschmidt presents a review of carbohydrate partitioning of citrus from a developmental perspective, and tackles the difficult question of whether carbohydrates, hormones, or

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both, control tree productivity. He also touches upon the important question of how molecular and genetic mechanisms control citrus productivity, as suggested by Koch (1996) and others. DeJong presents a modeling perspective of carbohydrate partitioning in deciduous tree fruit. He suggests that organ development and environmental conditions drive carbohydrate partitioning, and he presents several principles that have evolved from the modeling process to help understand how such partitioning occurs.

Continually increasing global atmospheric CO₂ levels is one aspect of the environment that will undoubtedly affect carbohydrate partitioning of plants, and possibly affect production. B. Schaffer et al. report on the effects of the interaction between atmospheric CO₂ levels and root restriction on photosynthesis and carbohydrate partitioning in several tropical tree fruits. They suggest that, for those tropical species, production will probably increase as CO₂ levels rise.

Although the effects of cultural practices and environment are of paramount importance, carbohydrate partitioning is ultimately regulated at the molecular level (Sonnewald and Willmitzer, 1992; Wardlaw, 1990). A. Schaffer et al. report on efforts to improve starch, sucrose, and fructose content of tomato fruit and thus improve flavor. Their work has involved the elucidation of the biochemical pathways where carbohydrate metabolism is governed, and the use of plants with modified carbohydrate metabolism and accumulation patterns. Tech-

niques involving both classical and molecular genetics are employed in this work.

Finally, Pharr et al. detail their work on the regulation of the metabolism of mannitol, a six-carbon alcohol that protects against salt and osmotic stress. The development of genetically engineered plants that would resist these stresses is dependent upon a better understanding of the processes involved in the biosynthesis and catabolism of mannitol.

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