The analysis of the impact of carbon source-sink relationships on flowering patterns reveals that apple tree growth and functioning are determined by mechanisms occurring at the tree and shoot scales.

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In apple, external (temperature and water stress) and internal (hormonal signaling, C source-sink relationships) factors are assumed to affect floral induction and, consequently to determine the fruiting behavior, regular or biennial. Nevertheless, no clear consensus exists on the role of each factor and on the level of plant organization at which the production patterns are determined.

One experiment was performed to analyze the C source-sink relationships of genotypes originated from a bi-parental cross and displaying large variability in production and flowering patterns. Within this population, four groups of genotypes were determined: (group 1) genotypes with biennial production of flowers in ON year, (2) biennial genotypes in OFF year, (3) regular genotypes resulting from a high production of floral growth units over years, (4) regular genotypes displaying, each year, an almost equal proportion of vegetative and reproductive shoots. The photosynthetic activity and the growth of vegetative and reproductive shoots were measured for four representative genotypes in each group. Two questions were addressed: (i) Are the flowering patterns related to different behaviors in term of photosynthetic activity and shoot growth? (ii) At which scale of plant organization the tree adjust its functioning to contrasted cropping conditions?

No clear experimental evidence showed that genotypic differences could be explained by differences in photosynthesis between groups. Indeed, no difference in photosynthesis was observed between genotypes of group 3 (regular but with a large proportion of floral meristems whatever the year) compared to biennial genotypes. For biennial genotypes, a higher photosynthesis rate was observed for group 1 (biennial in ON years) compared to those of group 2 (biennial in OFF years) suggesting a positive feed-back retroaction between source and sink activity. All the shoots (vegetative or reproductive) of group 4 reached a photosynthesis activity similar to reproductive shoots of group 1, thus suggesting a global regulation of photosynthesis at the tree scale. Conversely, shoot growth appeared determined at the shoot scale. Indeed for group 4, vegetative shoots (i.e. without local presence of fruit) were longer than reproductive shoots and reached the same length than the vegetative shoots of group 2 (trees in OFF year).

These results give new insights into the variability of source-sink relationships in apple within plant architecture. Indeed, shoot growth is determined by the shoot local context whereas leaf functioning is regulated at the plant scale.

Key words: photosynthesis, genotypic variability, multi-scale, architecture, biennial bearing.