Multi-scale high-throughput phenotyping of an apple tree core collection under water stress condition

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Large genotypic variation in traits related to plant performance under contrasted environmental conditions has been reported but phenotyping them on large population remains a challenge for trees grown in orchards. We currently investigate or adapt new technologies for phenotyping developmental and adaptive traits in an apple tree core collection composed of more than 1000 individuals and grown under well watered and water stressed conditions. Targeted traits are associated with tree architecture which determines many traits of plant functioning such as light interception efficiency and transpiration, photosynthesis or water use efficiency. At the tree scale, T-LIDAR scans associated with new reconstruction algorithms are used for extracting variables related to the vegetative development (plant leaf area and its spatial distribution; number and length of axes). At the leaf scale, chlorophyll fluorescence has been measured on all the trees of the collection for determining a semi-empirical index (I_{pL} index) previously shown to be a good proxy of photosynthesis activity. Multi-spectral and thermal IR airborne imaging is also carried out in summer in order to compute spectral indices that reveal phenotypic features over the whole field assay. The validity of high-throughput indicators are being assessed at both tree and leaf scales, through in-planta measurements of plant functioning such as architecture digitizing and leaf gas exchanges. Most of the traits collected exhibit a large variability with highly significant effects of water stress and genotype suggesting that methods are relevant for genetic studies. In that context, GWAS analyses are undertaken to identify genomic regions associated to the trait variation. In forthcoming works some of the parameters quantified in this study will be used to complement functional structural plant models for in-silico exploring the interaction between tree architecture and functioning under contrasted environments.

Key words : architecture, photosynthesis, transpiration, T-LIDAR, chlorophyll fluorescence, multi-spectral airborne imaging