Design and set up of a plant growth chamber for stable isotope labeling to investigate carbon attraction toward fruit sinks and plant reserves upon and after drought stress.

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Grapevine is a plant that adapts to periods of drought, which are correlated with berry quality. In perennial plants, the roots orchestrate the defense adaptations to drought, acting as a sink of the carbon (C) allocated during growth slowdowns, C which can beoechemically be released in the post-drought periods. In crops oriented to fruit production (and in this case in the grapevine) the root sink competes with fruits in receiving photosynthates during the growing season, and the competition increases with water stress.

In addition, the current climatic variations lead to the alternation of extreme events with periods of drought. The atmospheric CO₂ concentration, the triggering factor of the greenhouse effect, is constantly rising, and the C cycle in plants could partly mitigate the effect, but the high temperatures affect both photosrespiration and C dynamics in plant and soil.

We aim to study C allocation kinetics in grapevine organs in a controlled water deficit system basing on studies of C allocation, trough pulse-chasing isotopic strategy. The isotopic acts as a tracer of the fluoeamic flows that are oriented towards different sinks during drought/rehydration cycles. Grapevine fits well the subject of investigation, especially in relation to two well-known and deeply studied factors:

i) root: grapevines (Vitis vinifera L. cultivars) in commercial vineyards are grafted on different rootstocks, belonging to pure or hybrid genotypes of the genus Vitis.

This confers to root systems a wide spectrum of vigour, water relations, and strategies of resistance/resilience to water stress.

ii) fruit: grape berries belong to hundreds of cultivars, spread all over the world. Both fresh consume (table grapes) and berry to win transformation (oenological viticulture) point to maximize fruit quality, driving in-field ripening dynamics toward accumulation onto berries (skin, pulp and seeds) of sugars and secondary metabolites. This to improve taste and flavor of either fresh berries or their derived wines, and to protect them from detrimental reactions happening during fruit conservation, oenological technologies, and wine ageing.

Open questions:
- How are neosynthesized sugars translocated at different rates depending on the hydration status of the plant?
- Are these sugars during stress periods redistributed following different ratios toward different sinks?
- Is quality of the berry related to variations in delivery dynamics of sugars during water stress?
- Is rate of respiration of sugars different depending on whether or not water stress is present?

Experimental set up
Three treatments x three replicates (irrigated controls IRR, drought stressed plants WS, and re-hydrated recovering plants REC) simultaneously in the 13C labelling chamber (= 9 plants in the chamber). Three plants with optimum hydration act as a control for both the water stress line and the recovery line.

All plants during the translocation time (period following the pulse of 13C) are all exposed to the same environmental conditions, minimizing environmental (solar radiation, temperature, air humidity) influence on C translocation rates.

At the end of the 13C pulse: leaf sampling to know the amount of 13C assimilated by the square meter of leaf surface.

Time kinetics: Sampling leaves, berries, roots and soil at subsequent time points to understand deliveries of C toward sinks.

Once a maximum of 13C has reached the various districts, by repeating sampling it is possible an estimation of 13C leaving the distrit (respiration /re-translocation).

Results of preliminary investigation for setting air fluxes into the growth chamber for stable

Photosynthetic assimilation, stomatal regulation and respiration are checked in the various phases to size 13CO₂ enrichment flows in the chamber. Maximum assimilation ranges from 6 to 13 μmol m⁻² s⁻¹, reduced possibly by stomatal control 3 or 4 times at the end of the drought period. Light responses are evaluated to optimizing chamber illumination. A model optimizing light and temperature is possible for plants in the various stages of the experiment.

In the same sinks taken for isotopic analysis, the expression of genes involved in carbohydrate transport will be investigated. Genes encoding proteins that regulate the delivery of sucrose to the sinks and which catalyze the hydrolysis of the sucrose discharged to trigger respiration or C storage will be analyzed.

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