Development of Tree Carbohydrate Budget of Almonds Under Changing Central Valley Climatic Conditions

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PROJECT SUMMARY

General objectives:

- Develop tools for studying shoot physiology under variable environmental conditions including detailed analysis of starch and soluble sugar concentration dynamics, enzyme activity, and expression pattern of genes encoding enzymes from carbohydrate metabolism pathways.
- Determine the seasonal pattern of carbohydrate use by almond trees with a special focus on dormancy and bud break.
- Determine cumulative impact of abiotic stresses on carbohydrate transport and use including the combined effects of thermal and water stress.

Background and Discussion:

California's Central Valley in 2014/2015 experienced the most severe drought in more than 1,200 years. The drought effect is magnified by a slow climatic shift that is reducing the Valley's fog cover. The net result is an increased incidence of extreme thermal conditions during winter including: higher average temperatures, more severe frost nights, and hot sunny days.

These factors combined with the increasing use of saline ground water supplies necessitated by decreasing surface water supplies have produced an unprecedented set of new abiotic stresses that affect horticultural production. Vegetative life of any plant can be described as a continuous struggle to acquire, transfer, and store energy that is necessary to grow, reproduce, and protect from environmental abiotic and biotic stress.

Carbohydrates (sugars) are responsible for the majority of long distance energy transfers and long term storage of energy in plants. They are the ultimate currency that the plant has to interact with environment. The understanding of carbohydrate transfer and use as plants respond to environmental stress while accomplishing their reproductive functions (yield) is of key importance for predicting yields, determination of plant stress levels, and a plant's ability to mediate salinity, drought, or winter survival. Understanding of carbohydrate management is especially important in long-lived perennial crops like almond that must balance short-term (seasonal) vs multi-year benefits with effects being carried out over multiple years.

Initial efforts focused on detailed analysis of yearly carbohydrate (starch, sugars) dynamics in almond trees in relation to climate and tree phenology (efforts are ongoing). Partial results show that during the bud break period there is a short period of carbohydrate depletion in locations near flowers. After flowering; we observed reloading of the stems with carbohydrates released from limbs and stems toward the base of the tree. Reserves in these locations were almost exhausted and remained very low until late September, when pre-winter accumulation of starch was observed.

Flowers grown in field conditions were twice as large as on cut branches in the lab. This discrepancy might be related to carbohydrate availability and thermal mobilization of carbohydrates in the field; while under constant temperature lab conditions flowers only had access to carbohydrates located at the distances within 5 cm, in the field flowers appeared to be fed with carbohydrates from longer distances and transfer and release of sugar is proposed to be driven by a novel mechanism that depends on high diurnal variations in temperature.

Project Cooperators and Personnel: Aude Tixier – Postdoc, UC-Davis

For More Details, Visit

- Poster location 62, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2016) at Almonds.com/ResearchDatabase
- Related projects: 14-PREC1-DeJong; 15-PREC5-Volder