Evaluation of Leaf Heat Tolerance of Almond Germplasm in the UC Davis Almond Breeding Program

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PROJECT SUMMARY

Objectives:

- Provide a ranking of leaf heat tolerance of 100 almond genotypes and related species available to almond breeding programs.
- Establish a protocol for a high throughput, and appropriate, tool for estimating leaf heat tolerance for future use.
- Evaluate if tradeoffs exist that prevent the incorporation of heat tolerance into commercial germplasm.
- Determine the quantitative impact that a high heat tolerance has on photosynthetic performance.

Background and Discussion:

Crops are susceptible to heat damage under conditions where a reduction in evapotranspiration leads to hotter leaves. Issues such as increasing salinity and severe deficit irrigation will also likely make almonds more prone to stress under periods of extreme heat, particularly early in the season when leaf damage would have the greatest effect on productivity. Thus it would be useful to introgress germplasm with high heat tolerance into current breeding populations. Such germplasm must first be found amongst available breeding lines or wild germplasm available at the USDA National Clonal Germplasm Repository, Davis, CA. Screening for heat tolerance may be performed using a fluorescence probe of chlorophyll, the key pigment in light capture for photosynthesis.

In late spring and summer of 2014 a field trial was undertaken on mature *Nonpareil* almonds and on potted plants at the UC Davis Experimental Station. Irrigation was withheld from half of the field and some of the potted plants. These were monitored for stress and damage in response to high heat events using a permanent installation of a chlorophyll fluorometer. A validation was performed using photosynthesis measurements to determine if the intended method of ranking of almond germplasm is informative about almond heat tolerance. Finally, a number of almond varieties were evaluated for heat tolerance differences.

These data clearly demonstrate that commercial almond varieties, including *Nonpareil*, are very heat tolerant with respect to leaf stress tolerance and damage recovery. The likelihood of stress and leaf damage was enhanced greatly by the combination of high light, drought and air temperatures greater than ~95^{o}F. Photosynthetic recovery after exposure to high leaf temperature displayed two thresholds. Leaves reaching above 100^{o}F showed rapid recovery from the mild damage that occurred, while leaves exposed to 109 to 112^{o}F were severely damaged and recovery lasted about a week. Note that these values are leaf temperatures, and only under drought are almond leaves likely to reach these temperatures under normal growing conditions (90 to 110^{o}F air temperatures).

These experiments demonstrate that chlorophyll fluorescence is a suitable indicator of severe leaf damage and that damage does occur under a combination of stresses.

Work in the coming spring will focus on: 1) doing a full evaluation of variation in heat tolerance in the available germplasm, including wild species; and 2) continued monitoring of the conditions that cause heat stress in almonds. Related work aims to use the information gained here to improve global climate models by specifically representing photosynthetic heat stress tolerance using almond as the model species.

Project Cooperators and Personnel: Tom Gradziel, Nicolas Bambach, UC Davis; John Preece, USDA, Davis

For More Details, Visit

- Poster location 46, Exhibit Hall A + B during the Almond Conference; or on the web (after January 2015) at Almonds.com/ResearchDatabase
- Related project: 14-HORT1-Gradziel