Effects of dormant drought stress on *Prunis dulcis* bloom; Or, What if it doesn't rain in the winter?

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Problem and its Significance:

Little is known about the effects of dormant drought stress on tree crops. With the increasing likelihood of winter drought events, it is vital to determine if trees experience water stress during dormancy and if so, when is the best time during winter to irrigate. More research is needed to understand the influence of winter drought on bloom time, chill requirements, and yield potential.

Objective:

The objective of this research is to investigate the effects of winter drought stress on almond flower bud development. In the winter of 2016/2017, drought stress was applied to potted trees in order to quantify the effect on bloom.

Background:

In the winter of 2015/2016, a preliminary study was done using potted almond trees. The tentative conclusion was that dormant drought stress may cause a delay in bloom, however we were unable to establish the desired replicate levels and periods of stress.

Materials and Methods:

- Nonpareil on Nemaguard root stocks grown in 12-gal drip irrigated pots, planted in 2015, were used.
- Wheat seeds were planted in the pots in late summer and were strongly established by early November.
- All trees irrigated normally until November 10, then all trees, except 5 control trees, were removed from irrigation.
- All trees were moved to covered area November 14, in order to eliminate precipitation.
- Lack of irrigation and precipitation, in combination with the wheat, were used to establish drought stress.
- Once the trees reached the desired stem water potential (SWP), the wheat was cut and the trees were defoliated if necessary.
- 2 stress levels x 3 time periods (stages)= 6 treatments, 5 trees each.
  - Stage 1 trees were irrigated Dec. 21, Stage 2 trees were irrigated Jan. 13, and Stage 3 trees were irrigated Feb. 2.
- On February 6, all trees were removed from the rain shelter.
- Bloom progress was tracked by marking two branches on each tree and monitoring percentages of flower buds bloomed over time.

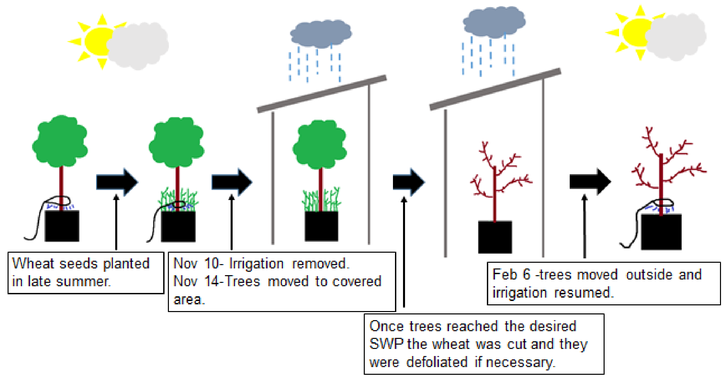

Figure 1. Experimental design used to simulate dormant drought conditions in order to establish and maintain drought stress.

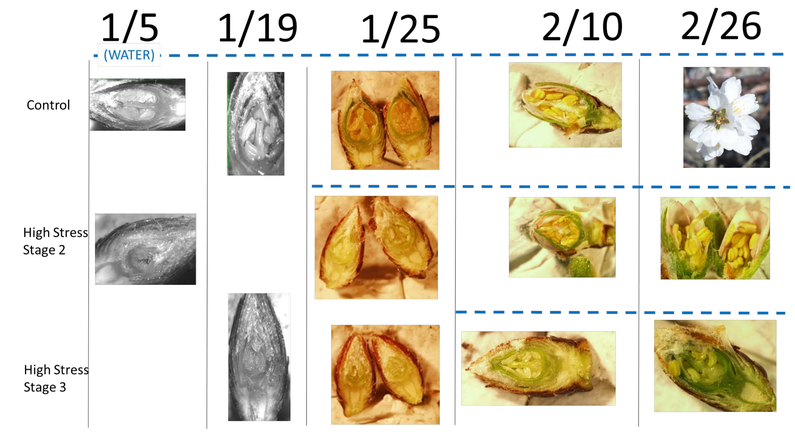

Figure 3. Cross Sections of flower buds of different treatments, blue line indicates when trees were irrigated (stress removed).

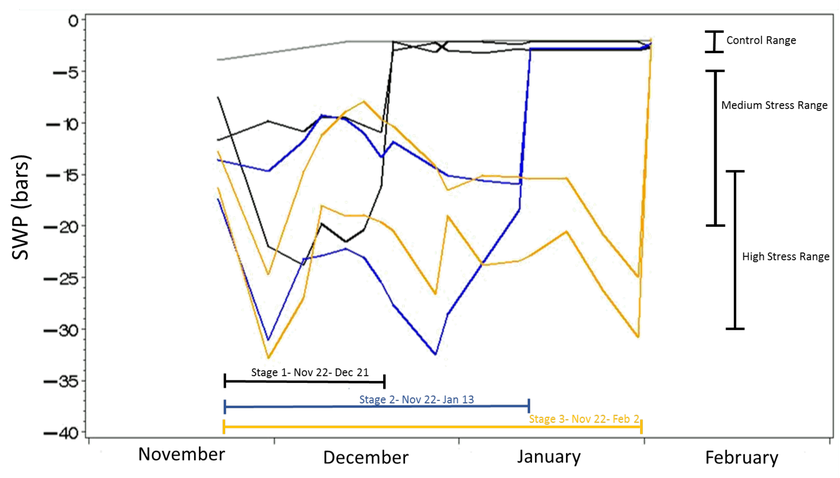

Figure 2. Stem water potential data of drought treatments over time. Two stress level ranges and times (stages) were established. Error bars indicate range for each stress level and controls.

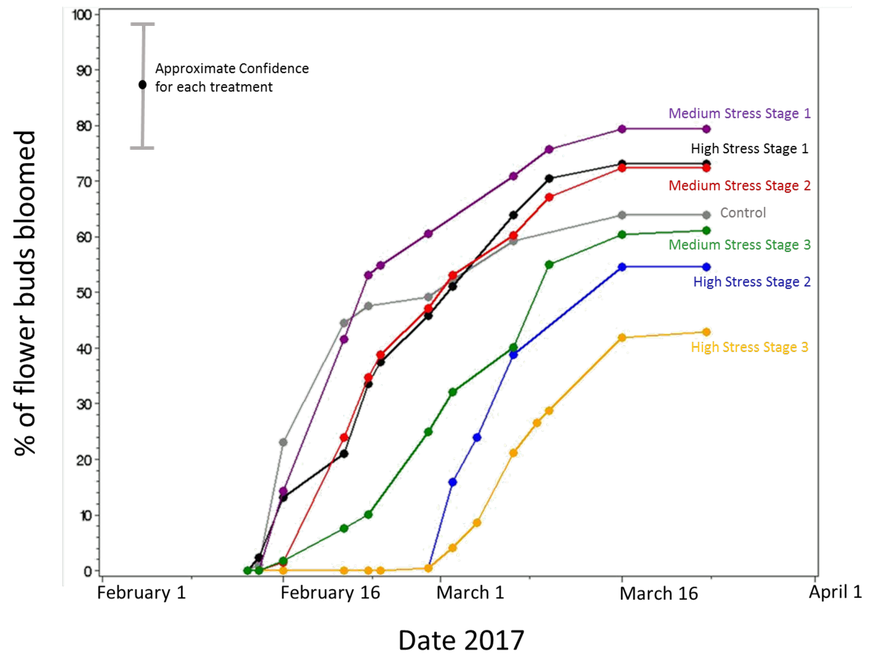

Figure 4. Treatment means of flower bud bloom percentage over time. Error bar indicates average ranges for treatments.

Results and Discussion:

- Irrigated trees had uniform and stable SWP values over time in the range of -1 to -3 bars, whereas trees in the stress treatments showed more variability both between trees and over time, ranging from -5 to -20 bars in the medium stress treatment and -15 to -30 bars in the high stress treatment (Fig. 2).
- Microscopy of dormant flower buds showed delayed development in high stress treatments (Fig. 3) and bud swell was also delayed in high stress treatments (data not shown).
- Analysis done using a combination of stress level and duration (Bardays).
  - Bardays= Stress x time.
  - For example, a tree that had a -2 bar stress for 70 days would have a bardays of -140, a tree with an average stress of -20 bars for 70 days would have a -1400 bardays, and a tree with an average stress of -20 bars for 30 days that was then irrigated and recovered to a -2 bar stress for 40 days would have a –680 bardays.
- Dates of first bloom had a range of ~28 days and these delays were strongly significant ($p<0.0001$) with a decrease in bardays (Fig. 4, 5).
- Leaf out dates had a range of ~ 7 days and were not significantly effected by a decrease in bardays (Fig. 5, dashed line).
- Even though stress caused a delayed bloom, nuts seemed to develop normally (Fig. 6).

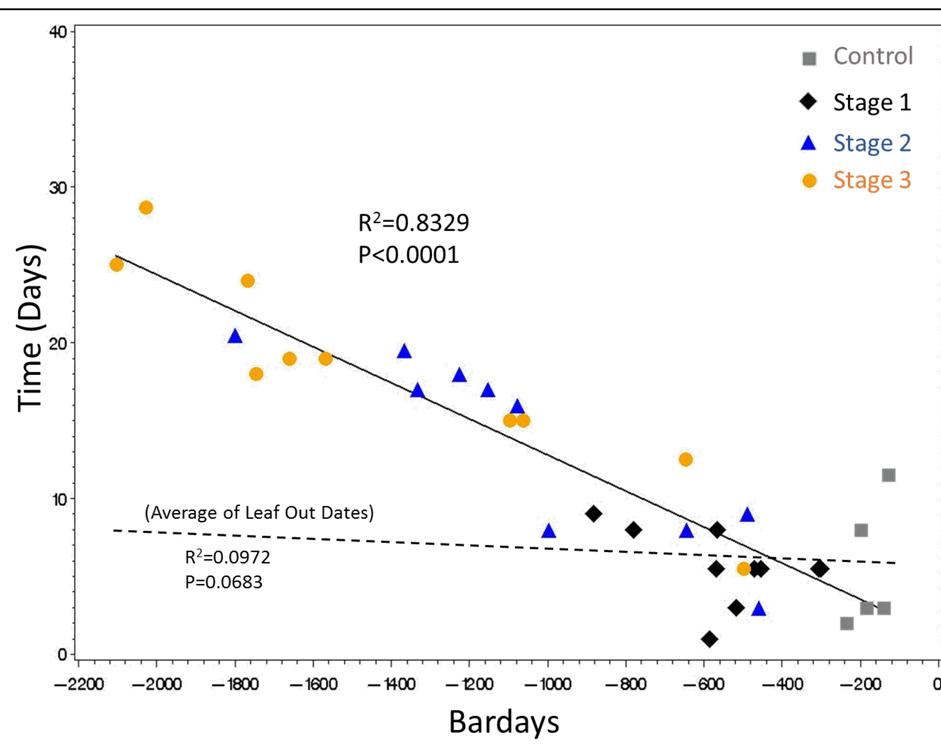

Figure 5. The dates of first bloom and leafout plotted against bardays. Dates of first bloom had a range of ~28 days yet leaf out dates (dashed line) had a range of ~ 7 days.

Conclusions:

Our data indicates that dormant drought stress in *Prunis dulcis* can cause a bloom delay but does not otherwise effect flower bud development. The stress treatments had physiological and developmental effects in our potted tree study. In the field, dormant SWP values of -2 bars for irrigated trees and -8.3 bars for non irrigated trees have been observed (Milliron et al., in press). Using a 72 day period, this gives values of -144 and -598 bardays. The regression line produced by our data (Fig. 5) would predict a bloom delay of ~5 days, which is substantial. Hence dormant drought stress can cause significant effects in orchards and should be studied further under field conditions.

Figure 6. Cross sections of nuts from trees of different treatments, harvested and photographed May 6.