

Project title: Overcoming citrus nursery growth issues by using Smart Lighting with Different Photoperiods

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Objectives:

To understand growth responses of various citrus scion-rootstock combinations to various LED lighting intensities, wavelengths and photoperiod regimes and compare these responses to conventional lighting systems. This study aims to:

- Increase bud set of scions in fall budded trees
- Decrease time to bud break post-budding
- Increase elongation of scions post-budding
- Increase scion and rootstock caliper
- Increase root growth of rootstock under different LED lights
- Quantify photosynthesis under different treatments

Problem/background:

Faster year-round propagation is critical for nurseries to offset the investment in new insect exclusion facilities due to HLB scare. Citrus nurseries currently face a serious problem of poor bud push, slow scion growth and lower trunk girth in fall-budded container grown trees. Use of supplemental light in most economical ways will be explored as a means to improve grafting success and growth during seasons with a short photoperiod. Currently very few nurseries use light and that too just to extend photoperiod with conventional lighting that burns energy for long hours, costing thousands of dollars. There is interest in research work using LED lights with smart lighting regimes to enhance plant growth by tapping classic physiological responses of plants.

This work was proposed to explore the use of supplemental lighting in growth chambers and greenhouse settings to improve production during seasons with a short photoperiod.

Progress:

The first phase of this project was started with a preliminary run of the growth chamber experiment starting in June 2018. In late May, 144 trees were brought from Tree Source nursery in Woodlake, Ca, out of which 72 were non-budded Carrizo trees and another 72 were budded with Clementine mandarins. At arrival these trees were repotted into 4"x4" alley pots in a coconut coir growing medium. The trees were acclimated in a greenhouse in California State University for two weeks before being placed in growth chambers (A1000, Conviron, Inc, Winnipeg, Canada) for various treatments.

After two weeks, 12 trees of each kind (budded and non-budded) were placed in each of the 6 chamber with a total number of trees per chamber being 24. Chambers 1 through 6 were set as per the conditions described in table 1. Each chamber was set to a light intensity so that total daily light integral was 27 for each of the chambers. The baseline light intensity of the chambers was 750 for a 10 hour daylength and light intensity calculations for each chamber were done based on this number.

Table 1: Detail of the treatments/light regimes for 6 growth chambers.

Chamber #	Treatment	Light Fixture	Temperature and RH%
1	10 Hour LED	Lumigrow LED 650e	Day: 28 ⁰ C; Night: 21 ⁰ C RH: 65% continuous
2	10 Hour LED with Night Interruption – Low	Lumigrow LED 650e	
3	10 Hour LED with Night Interruption – High	Lumigrow LED 650e	
4	10 Hour LED with Day Extension - High	Lumigrow LED 650e	
5	10 Hour LED with Day Extension - Low	Lumigrow LED 650e	
6	10 Hour Fluorescent with Night Interruption	Chamber Fluorescent lights (Conviron)	

Table 2: Daily light integral values for each chamber

Chamber	Intensity 1	Hours 1	DLI 1	Intensity 2	Hours 2	DLI 2	Total DLI
1	750	10	27	0	0	0	27
2	744	10	26.784	60	1	0.216	27
3	682	10	24.55	682	1	2.45	27
4	535	10	19.26	535	4	7.74	27
5	726	10	26.14	60	4	0.86	27
6	744	10	26.784	60	1	0.216	27

The trees were grown in chambers for 12 weeks. The trees were watered based on volumetric measurements of water use done periodically to assess tree water use. The fertilization was done 3 times during the experimental period as per the standard industry practices.

Measurements taken: Weekly growth measurements were taken for both budded and non budded plants in each chamber. These included shoot length, number of leaves and number of branches. Instantaneous photosynthesis was taken on one selected leaf on 3 trees per treatment every other week. Chlorophyll content measurements were taken once towards the end of the experiment. The data on weekly photosynthesis and stomatal conductance have not been analyzed yet. After the trees were harvested during second week of September, they were partitioned into above ground and below ground parts and fresh weight were taken and the samples dried in oven at 65°C for 48 hours. The data for dry weight were recorded and then root-to-shoot ratio was calculated. These samples were then grinded and are being analyzed for non-structural carbohydrate content.

Preliminary results: The graphs representing the results from budded trees are given at the end of this file. Significant differences were found between light treatments in terms of growth, number of leaves, number of branches, fresh and dry weights of above-ground and below ground parts; and chlorophyll content of the leaves. Two LED treatments, 10 hour LED with low light intensity night interrupt and LED with day-length extension with low intensity (Chamber number 2 and 5 respectively) clearly showed advantages over the conventional fluorescent lights with night interrupt. The non-budded Carrizo rootstock trees did not show any observable growth in any of the chambers. The reason could be that

they were headed a day before being moved to the growth chambers and did not get any acclimation time. Next time, they will be headed back earlier.

These preliminary results will be critically analyzed by the research team and next run of the experiment will be planned accordingly.

Conclusion: The first preliminary run of the experiment was completed successfully. We got encouraging results although the first run was challenging as we worked through controlling and maintaining experimental conditions like light intensity, temperature and relative humidity. The goal of this preliminary run was to standardize the materials and methods and learn about the best way to control and stabilize experimental conditions. The first run of the experiment accomplished those goals.

The second experiment is being setup currently and the treatments will be slightly modified based on the results we got in the first experiment. Another treatment 'Extension of Day-length with Far-Red' is being included this time.









