IFAS Citrus Initiative  
Annual Research and Extension Progress Report 2007-08  
Mechanical Harvesting and Abscission  
Tree Health

Investigators: J.P. Syvertsen, J.C. Melgar (postdoc) and A. Kusakabe (PhD grad student)  
Collaborators: J.K. Burns, T.M. Spann, K. Morgan, R. Ebel and F.M. Roka

Objectives Pursued:  
1) Prolonging late season ‘Valencia’ harvest. 
Delaying spring bloom without yield loss using drought stress during winter:  
Our hypothesis is that delaying bloom with drought stress in winter in ‘Valencia’ can improve late season harvesting in ‘Valencia’. If bloom can be delayed 3 weeks, younger fruitlets should be smaller and less susceptible to late season mechanical harvesting losses after May.  

Progress:  
Detailed Accomplishments in 2007-08:  
2007: ‘Valencia’ flush growth and bloom were successfully delayed 2-3 weeks by winter-time drought stressed compared to timing of bloom in well irrigated trees. We did late season mechanical and hand harvests in May, June and July 2007. Previous drought stress did not cause any changes in mature fruit yield, percentage of juice or juice quality in the 2007 crop but tended to increase percentage fruit removal and MH efficiency. In June 2007, the young fruitlets were small enough so as not to be mechanically harvested with the mature crop. Fruitlet abscission of the next year’s pea-sized fruit in previously drought stressed trees was much less than the larger green fruit that were generally greater than 1 inch in diameter on previously rainfed plus irrigated trees.  
2008: Measurements of growing fruit size throughout the fall 2007 and winter 2008 showed that later fruits from previously drought stressed trees matured normally and fruit size caught up with earlier fruits from irrigated trees. Winter time drought stress treatments were applied again from Jan 2007 – March 2008 when irrigation was not applied and artificial ground covers of Tyvek were used as rain-out shelters for 100 days to exclude rain. Irrigation was resumed in all trees in March 2008. To test for any carry over effects from previous drought treatments, half of the drought stressed trees in winter 2007 were droughted again in 2008 while the other half of droughted trees in 2008 were from well irrigated trees in 2007. Treatments worked well again as in 2007 and bloom was successfully delayed for 2-3 weeks in 2008, regardless of the 2007 treatment. No differences between previous drought treatments were observed in fruit size or juice quality in 2008 crop. Ongoing fruit growth measurements and yield in 2009 will reveal any fruit quality or yield effects.

Impact of accomplishments towards overall goals of funding:  
This work is making strides towards improving safe late season harvesting in previously drought stressed ‘Valencia’. Mechanical harvesting during peak bloom (~March) in ‘Valencia’ can remove some flowers but does not diminish fruit set. During later season mechanical harvesting
of ‘Valencia’, as long as the diameter of young green ‘Valencia’ fruit is less than about one inch, mechanical harvesting does not reduce yields the following year. Once the young fruitlets exceed this size, however, aggressive trunk or canopy shaking will likely depress the following year’s yield by as much as 25%. Winter time drought stress seems to be effective in delaying bloom without causing effects on present yield, percentage of juice or juice quality. Result may allow growers to identify specific blocks for late season harvesting and use winter drought to delay flowering and decrease next season’s young fruit loss.

Presentations associated with 2007-08 efforts:

Next steps:
The plan for 2008 will be to continue evaluations of winter time drought stress effects on late season harvest and study any carry over effects from last year’s drought stress treatments.

Objective Pursued:
2) Drought stress on fruit detachment force.
Understanding the effect of drought stress on fruit detachment force (FDF) is essential if we are interested on mechanically harvest ‘Valencia’ trees.

Progress:
Detailed Accomplishments in 2007-08:
First FDF evaluations were done at the beginning of April 2007, after stressing the trees for a period of 3 weeks. Results indicated that drought stressed trees had a lower FDF than control trees when harvested early in the morning. Fruit weight and size, and percentage of juice were also determined. Fruit weight in stressed trees harvested in the morning was lower than in controls, although no differences were observed in the afternoon. Fruit weight in irrigated trees was lower during the central hours of the day than in the morning, but there were no changes in fruit weight in drought stressed trees as a consequence of time of day. Fruit % juice was lower in drought stressed trees than in irrigated trees, although this has to be confirmed. No differences were observed in fruit size.
This experiment was repeated on April 2008 with similar results. It was also repeated on February 2008, although FDF evaluations in drought stressed trees showed a different behavior than in April.

Impact of accomplishments towards overall goals of funding:
Determining the effect of drought stress on FDF has implications on the effect of tree water status, rootstock, time of day and abscission chemical sprays on the minimum required machine force for successful and safe mechanical harvesting. Probably the application of an abscission agent can magnify the differences between controls and stressed trees.
Next steps:
Evaluating FDF again in February 2009 to confirm the differences observed between the two
different dates (end of winter and mid-spring).
Evaluating FDF in drought stressed plants with/without application of an abscission agent

Objective Pursued:
3) Use of partial root zone drying and deficit irrigation to control drought stress in citrus.
Greenhouse experiments to assess the physiological impact of partial root zone drying and deficit
irrigation on citrus trees.

Progress:
Detailed Accomplishments in 2007-08:
A partial root zone drying (PRD) experiment was carried out in a greenhouse with seedlings of
Swingle with root system split in half and established in adjacent pots. PRD saved a considerable
amount of water but did not affect any growth or gas exchange parameters. Overall, PRD plants
behaved similarly to control plants. Similar plants with intact root systems were used for the
Deficit Irrigation (DI) experiments but deficit irrigation decreased growth. Thus, PRD treatments
saved water without reducing growth whereas DI limited growth. Ongoing studies will determine
interactions between drought stress, cold temperatures and water quality.

Presentations associated with 2007-08 efforts:
-Melgar, J.C., Dunlop, J. and Syvertsen, J.P. 2008. Effects of partial rootzone drying and
regulated deficit irrigation on seedlings of the citrus rootstock Swingle citrumelo. ASHS Annual
Conference, 21-24 July, Orlando, FL.
and without salinity affects water use efficiency of Citrus. ASHS Annual Conference, 21-24
July, Orlando, FL.

Objective 3a : Cold tolerance and winter water stress in citrus trees
If controlled drought stress in winter is to be of practical significance, potential interactions with
cold hardiness need to be assessed. We studied interacting effects of winter drought stress on
cold hardiness in potted citrus trees.

Progress:
Detailed Accomplishments in 2007-08:
Trees were grown inside and outside the greenhouse under water stress or well watered
conditions. Effects of winter drought stress on cold tolerance were evaluated by calculating leaf
freezing point. Results are still being analyzed.

Objective Pursued:
4) Impact of using different water regimes and nitrogen fertigation to control root growth
in citrus trees.
Greenhouse studies on the influence of irrigation timing and nitrogen fertigation on the control of
root/shoot growth and drought stress.
Progress:
Detailed Accomplishments in 2007-08:
When different frequencies of fertigation were applied, plants receiving frequent short water pulses lost more water than those receiving the same amount of water but applied at a lower frequency. No differences in shoot or root length were found, although specific root length decreased with frequency of irrigation.

Impact of accomplishments towards overall goals of funding:
These results have implications for using intensively managed (open hydroponic) systems to control drought stress, plant growth and flushing frequency.

Next steps:
The influence of nitrogen fertigation using water pulses for controlling root and flush growth is ongoing. Intensively managed fertigation trials in the fields are being developed using existing trees and newly planted trees.
The effect of irrigation scheduling prior to, and after mechanical harvesting on short-term tree health.

Investigators:
Kelly Morgan, Bob Ebel, Jackie Burns and Jim Syvertsen

Objective(s) Pursued:
The objectives of this study was to determine the effect of soil water depletion in the irrigated zone prior to and immediately after mechanical harvesting on 1) short-term tree health and 2) efficacy of 5-Chloro-3-methyl-4-nitro-1H-pyrazole (CMNP).

Progress on Objectives:

Detailed Accomplishments in 2007-08:
Two studies were conducted in 2007-08, one on ‘Hamlin’ in Jan./Feb 2008 and the other on ‘Valencia’ in April/May 2008. Drought stress was induced by withholding irrigation water to ‘Hamlin’ orange trees for 5 (control), 12 or 19 days before harvest and ‘Valencia’ orange trees for 0 (control), 4 or 7 days prior to harvest. As expected, soil moisture, leaf conductance, transpiration and stem water potential were lower for the drought treatments compared with the controls in both studies. Irrigation was restarted in all plots on the day after harvest. Leaf conductance, transpiration and stem water potential values for drought treated trees were similar to control trees by 5 days after harvest. CMNP substantially decreased fruit detachment force and fruit drop compared with the control. However, there was no significant interaction between drought stress and CMNP on fruit detachment force (FDF) or fruit drop for either scion variety. These results indicate that short term drought stress as imposed in this study and that occurs occasionally in commercial groves from disruptions in irrigation does not alter efficacy of CMNP.

Areas where progress exceeded expectations:
This study was initiated because growers in the Southwest Florida production area offered antidotal evidence of poor tree health after mechanical harvesting under drought conditions. The results of this work demonstrates that mechanical harvesting has little impact on short term water relations of citrus trees even if drought conditions exist prior to harvest. The lack of significant interactions in this study between CMNP and drought stress on FDF and fruit drop indicate that these levels of drought stress will not require significant adjustments in CMNP scheduling for mechanical harvesting.

Areas where progress didn’t meet expectations:
None

Impact of accomplishments towards overall goals of funding:
The levels of drought stress imposed in this study were generally slight to moderate, based on plant water status measurements. These levels of drought stress often occur in commercial groves due to malfunctioning pumps, breaks in the irrigation lines, and from plugged lines and emitters. A lack of knowledge existed regarding the effect of scheduling prior to harvest on short-term tree health. Results of this project have added to the knowledge base regarding the interaction of irrigation and mechanical harvesting and will reduce growers hesitation in implementing mechanical harvesting in dry years. The data provided by this study will also aid in acceptance of mechanical harvesting by giving citrus growers specific guidelines for irrigation management in insure continued tree health.

Presentations associated with 2007-08 efforts:
Mechanical Harvesting Council 6 May 2008
Mechanical Harvesting Advisory Committee 7 May 2008
Annual Meeting of the Florida State Horticultural Society 3 June 2008

Publications from 2007-08 efforts:

Next steps:
To confirm the results outlined above, the same treatments will be repeated using the same trees and drought and CMNP treatments. Yield impacts can be assessed to determine any long term effects of the drought or CMNP treatments. The information gained in these two years of data collection will be added to the relationships used in building a CMNP use model. National refereed journal papers on these data will be produced.