

# IFAS Citrus Initiative

## Research and/or Extension progress report 2012-13

### Investigator(s):

PI – Robert C. Ebel

Co-PIs – Fritz Roka, Kelly Morgan

### **Objective(s) Pursued:** (Abscission management and harvester efficiency)

Objective 1: Develop best management practices for harvester settings utilizing the abscission agent CMNP to maximize harvest efficiency.

Objective 2: Effect of CMNP on hand harvesting of sweet oranges.

Objective 3: Enhance understanding of the mode of action of CMNP in promoting abscission.

### **Progress on Objectives:**

#### Detailed Accomplishments in 2012-13:

*Objective 1: Develop best management practices for harvester settings utilizing the abscission agent CMNP to maximize harvest efficiency.* A major field study was initiated in 2011 to evaluate the use of CMNP on the late season Valencia harvest by self-propelled canopy shakers. The specific objectives are: 1) to determine the interaction of CMNP application and 2 canopy shaker frequency settings, the setting used by commercial operators, and a lower setting that was 40 cpm less than the higher setting, on fruit removal, fruit recovery, deck loss, and gleaning, 2) to determine the carry over effect on yield for each treatment in comparison to the controls.

This study was replicated 4 times beginning in early May, 2011 and 2012 and conducted every 2 weeks. CMNP was applied at the maximum label rate (300 ppm and 300 gal/acre) and the trees harvested 4 days later. Approximately 130 trees per treatment were used. The machine settings varied for each harvest in consultation with the commercial harvest managers, but the lower setting was always 40 cpm less than the higher setting. The tractors were run at 1.0 mph for all trials. There was also a hand harvested control that was not treated with CMNP. Data collected included diameter of newly developing fruit and weights of preharvest fruit drop, fruit removed, fruit not captured by the deck during the harvesting process, and fruit left in the tree that had to be gleaned. This study was in its second year in 2012. Yield data was collected in 2013 to determine carry over effect.

*Objective 2: Effect of CMNP on hand harvesting of sweet oranges.* This work was under the leadership of Fritz Roka. In the event a suitable method of mechanical harvesting cannot be developed for late season 'Valencia', the question was posed as to whether CMNP can improve worker efficiency sufficiently to economically justify its use. Two trials were initiated using workers that first harvested trees not treated with CMNP and then harvested trees that were sprayed with CMNP. The trials were conducted in April and May in two commercial groves. CMNP was sprayed at the maximum label rate and 3 days after application the trees were harvested. Throughout the day, the amount of fruit picked by each worker was recorded.

*Objective 3: Enhance understanding of the mode of action of CMNP in promoting abscission and based on the results develop a mechanistic model that describes loosening as influenced by temperature.* This project and is designed to increase our understanding of the mode of action of

CMNP, which we believe may help in development of best management practices. Our original hypothesis was that CMNP promoted high levels of nitrous oxide (NO) which was then a signal that promoted abscission. However, after careful studies of the amount of NO being produced in the flavedo and abscission zone tissues, the amount of NO is not high enough to promote abscission. Alternatively, low levels of NO can promote healing and the levels we found are in that range. After CMNP application, loosening increases up to 5 days after which the pedicel retightens. NO may be involved in the healing process in the abscission zone.

We have also determined the effects of CMNP on oxidative metabolism and reactive oxygen species (ROS) in flavedo and the abscission zone. CMNP promotes production of H<sub>2</sub>O<sub>2</sub> and alters enzymes involved its metabolism. An interesting outcome from this work is a differential response of oxidative metabolism in the abscission zone and flavedo tissues. Oxidative metabolism is substantially altered in flavedo tissue however there is little effect in the abscission zone. These results may indicate that CMNP does not readily traverse to the abscission zone after application. Thus, loosening would be caused by a signal produced in flavedo tissues and transported to the abscission.

Areas where progress didn't meet expectations:

Objective 1: The late season trial with 'Valencia' and CMNP indicates that canopy shakers will have to be terminated in most years due to excessive yield reduction the following year. Different methods of mechanical harvesting will have to be developed to mechanically remove this fruit.

Objective 2: This data needs to be analyzed before gaps can be identified.

Objective 3: Understanding the mechanism of CMNP and especially how air temperature affects efficacy is vital to developing best management practices. We have concluded based on the oxidative metabolism work that the most likely mode of action of CMNP is that it produces a signal in the flavedo tissue and that this signal moves to the abscission zone to promote abscission. We are currently testing a hypothesis of the identity of this signal.

Presentations associated with 2012-13 efforts:

1. S. Sharma, **R. Ebel**, and N. Kumar. **2012**. Role of nitric oxide in promoting abscission in citrus by the abscission agent CMNP. Amer. Soc. Hort. Sci., Miami, FL, July 31<sup>st</sup> – Aug. 3<sup>rd</sup>. (Abstr.)
2. **R.C. Ebel**. **2012**. Update on the late season 'Valencia' trials: Preliminary results. Southwest Florida Research Advisory Meeting, SWFREC, Immokalee, FL, June 22<sup>nd</sup>. (25 participants).
3. N. Kumar and **R.C. Ebel**. **2013**. CMNP induced oxidative changes in Valencia: I. Flavedo tissue. Florida State Horticulture Society, Sarasota, FL, June 2-4. (Abstr.)

4. N. Kumar and **R.C. Ebel**. 2013. CMNP induced oxidative changes in Valencia: II. Abscission tissue. Florida State Horticulture Society, Sarasota, FL, June 2-4. (Abstr.)
5. N. Kumar and **R.C. Ebel**. 2013. Canker control using commercially available compounds. Florida State Horticulture Society, Sarasota, FL, June 2-4. (Abstr.)

Refereed and non-refereed publications from 2012-13 efforts:

1. S. Sharma, **R.C. Ebel**, and N. Kumar. 2012. Production of nitric oxide by the abscission agent CMNP and its impact on citrus fruit loosening. Proc. Fla. State Hort. Soc., in press.
2. U. Handique, **R.C. Ebel**, and K.T. Morgan. 2012. Influence of soil-applied fertilizer on greening development in new growth flushes of sweet orange. Proc. Fla. State Hort. Soc., in press.
3. N. Kumar, **R.C. Ebel**, and P.D. Roberts. 2012. Effect of high temperature on different genotypes of citrus and kumquat. Proc. Fla. State Hort. Soc., in press.
4. N. Kumar, **R.C. Ebel**, and P.D. Roberts. 2012. Responses of Chinese citron during *Xanthomonas citri* pv. *citri* invasion. Proc. Fla. State Hort. Soc., in press.
5. N. Kumar and **R.C. Ebel**. Changes in oxidative metabolism in sweet orange 'Valencia' flavedo tissue by the abscission agent 5-chloro-3-methyl-4-nitro-1H-pyrazole (CMNP). Environmental and experimental botany, submitted.

Next steps:

Objective 1: Develop best management practices for harvester settings utilizing the abscission agent CMNP to maximize harvest efficiency. I plan to work with Fritz Roka to analyze the data from the late season trial conducted at Lykes.

Objective 2: Effect of CMNP on hand harvesting of sweet oranges. I plan to work with Fritz Roka on analyzing the data for the hand harvesting trials

Objective 3: Enhance understanding of the mode of action of CMNP in promoting abscission. We have one paper submitted and are working on a second on the effect of CMNP on oxidative metabolism of the flavedo and abscission zone tissues. I am also working with the PhD student Sunehali Sharma on preparing a manuscript for the nitric oxide work and we are conducting studies on a new hypothesis we believe is the signal for CMNP. This work will also be published. I don't think we'll have time to determine the impact of temperature on this process, thus the model we have developed empirically will be published.