HLB related fruit drop – Fall 2013 PGR trials

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Background – Fruit Drop

- Fruit drop very high in 2012-13
- Weak trees (HLB?) more loss than healthy trees?
- NASS reduced yield estimate more than 10% due to excess drop and small fruit size.
- Is this primarily due to tree decline from HLB?
Preharvest fruit drop is known to vary from year to year.

NASS (FASS) reported that 2012-13 was worst since 1969-70, now maybe worst ever?
- High or low drop year established before harvest season
- Drop rate increases 2-3 % per month during harvest

What are characteristics of preharvest fruit drop?
4 to 10 % drop - November, 9 to 16 % - January
Pre-HLB Citrus Fruit Drop Data

- Pre 1989 data January or April
  - Early-mid season > 6.2 to 18.4 %
  - Late season > 12.4 to 37.3 %

- Post 1988 data
  - Early-mid season > 3.0 to 19.9 %
  - Late season > 5.9 to 37.2 %

- Highest late season probably freeze years
NASS Fruit Drop Data – 2013 and 2014

<table>
<thead>
<tr>
<th>Oranges</th>
<th>2013 Frt/tree</th>
<th>2013 % Drop</th>
<th>2014 Frt/tree</th>
<th>2014 % Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early-mid</td>
<td>1032</td>
<td>18</td>
<td>918</td>
<td>23</td>
</tr>
<tr>
<td>Navel</td>
<td>409</td>
<td>27</td>
<td>429</td>
<td>19</td>
</tr>
<tr>
<td>Late Season</td>
<td>661</td>
<td>22</td>
<td>614</td>
<td>31</td>
</tr>
<tr>
<td><strong>Grapefruit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>550</td>
<td>22</td>
<td>555</td>
<td>29</td>
</tr>
<tr>
<td>Colored</td>
<td>492</td>
<td>20</td>
<td>500</td>
<td>25</td>
</tr>
</tbody>
</table>

Processing orange drop increased 5 or 9 % from 2013 to 2014 and grapefruit drop increased 5 to 7 % depending on cultivar.
Fruit drop process
Stress induced fruit drop

Stress >>> Ethylene >>> Cell wall breakdown >>> Abscission
Fruit abscission zone

- Water stress- root loss
- Nutrient imbalance
- Carbohydrate deficiency
- Las produced toxin or signal
- Fruit peel senescence
- Herbicides?
# Tree Decline Effect on % Fruit Drop

<table>
<thead>
<tr>
<th>Grove</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 T1</td>
<td>0.33</td>
<td>0.45</td>
<td>0.58</td>
</tr>
<tr>
<td>G1 T2</td>
<td>0.31</td>
<td>0.47</td>
<td>0.55</td>
</tr>
<tr>
<td>G1 T2</td>
<td>0.32</td>
<td>0.44</td>
<td>0.42</td>
</tr>
<tr>
<td>G2 T1</td>
<td>0.3</td>
<td>0.31</td>
<td>0.36</td>
</tr>
<tr>
<td>G2 T2</td>
<td>0.3</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>G2 T3</td>
<td>0.26</td>
<td>0.31</td>
<td>0.32</td>
</tr>
<tr>
<td>G3 T1</td>
<td>0.48</td>
<td>0.59</td>
<td>0.58</td>
</tr>
<tr>
<td>G3 T2</td>
<td>0.4</td>
<td>0.54</td>
<td>0.59</td>
</tr>
<tr>
<td>G3 T3</td>
<td>0.43</td>
<td>0.53</td>
<td>0.57</td>
</tr>
</tbody>
</table>

|   | 0.35 | 0.44 | 0.48 |

Valencia orange 2014 season.  
Tree condition best to significant decline = 1 to 3
Tree Decline Effect on Stem Water Potential = Water Stress

Block 1 - Before harvest

Block 2 – Before harvest

Block 1 – After harvest

Block 2 – After harvest
Drought effect on ethylene production and abscission

- Drought reduces xylem flow and causes ABA to accumulate
- Rehydration allows ACC to flow from roots to leaves and fruit
  - ACC converted to C$_2$H$_4$ in mature fruit and leaves, but auxins block in young leaves and GA blocks in young fruit
  - Externally applied GA may reduce ethylene and drop in mature fruit
ABA, ACC, ethylene changes with drought
Short of solving HLB, what can we do about excessive drop

- Look at production practices in relationship to known changes due to HLB
  - Increase irrigation frequency because of less root system
  - Change herbicides and timing if more vulnerable root system
  - Use materials to improve tree health even w/HLB – enhanced foliar nutrition, water quality
  - Use Plant Growth Regulators to directly reduce preharvest fruit drop
Some available plant growth regulators

- **2, 4-D** – inhibits up-regulation of cell wall dissolving enzymes, reduces abscission
- **NAA** – another auxin substitute, but traditionally used for fruit thinning
- **Gibberellic acid** – delays peel color change & retains firmness (delays senescence?), blocks some phases of ethylene production from drought
- **ABA** – anti-gibberellin, slows growth
- **AVG** – reduces early apple drop, anti-ethylene
- **MCP-1** – Blocks ethylene action
- **Cytokinins** – cell division, essential for flowers
Fall applications of PGRs

- Treated Pineapple, Valencia, Grapefruit and Murcott
- Two applications September and October
- Used Citrus Fix (2, 4-D), PoMaxa (NAA), ProGibb (GA) in all combinations +Kinetic
- Also tested S-ABA, AVG (Retain) and a different formulation of ProGibb
Application Rates of PGRs

- ProGibb – 20 g ai/acre
- Citrus Fix (2, 4-D) – 1.28 fl oz (45%)/acre
- PoMaxa (NAA) – 40 fl oz (100ppm)/acre
- S-ABA – 100 g ai/acre
- Retain (AVG) – 100 g ai/acre
Results

- Numerically, many times ProGibb + Citrus Fix one of lower treatments for % drop
  - Oranges and Murcott particularly, not grapefruit
  - Usually 5 to 10 % difference from control
  - Variance too high probably due to tree decline stages in plots, need larger plots and decline as variable within plots
- December trials by others gave mixed results
- Late January or February treatments to Valencia generally did not give positive result
Additional tests

- Late winter applications to Valencia trees
  - Citrus Fix, Retain, I-MCP, PoMaxa
    - Late Jan or early Feb - no apparent effect
    - Three to five sites
    - Did not try GA – concern for effect on flowering

- Season long 2, 4-D, Cytokinin and GA test
  - One quarter rate to be applied every 45 days of first 2 and GA applied 3 times to soil
  - Two cultivars, 5 sites
Greenhouse soil GA test

<table>
<thead>
<tr>
<th>GA applied</th>
<th>Control</th>
<th>.00125 gm/plant</th>
<th>.0025 gm/plant</th>
<th>.005 gm/plant</th>
<th>.0063 gm/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg root #</td>
<td>11.8</td>
<td>14.3</td>
<td>14.7</td>
<td>16.3</td>
<td>15.5</td>
</tr>
<tr>
<td>Avg root length</td>
<td>31.8</td>
<td>31.9</td>
<td>34.1</td>
<td>40.5</td>
<td>40.7</td>
</tr>
</tbody>
</table>

Six weeks, 6 replications, gm ai GA

Will soil applied GA stimulate root growth in HLB affected trees?

Plan greenhouse test and field tests underway
Summary

These past two years indicate that we should expect to have problem with excessive fruit drop on declining trees.

This first year of extensive PGR tests indicates that traditional 2, 4-D and ProGibb may help reduce fruit drop some. Need more extensive tests.

With higher levels of HLB affected trees in groves, poorer delivered quality to processors?

Can we improve this situation?