Management of Cropload on Honeycrisp to optimize fruit quality and return bloom

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Research supported by:
- Michigan Apple Research Committee
- Michigan State Horticultural Society
- Project GREEEN
- Michigan Agricultural Experiment Station
- Michigan Growers

Special thanks to growers:
- Wittenbach
- Schwallier
- Evans
- Gregory
- Prilliwitz
- Jelenick
THE PROBLEM

Factors Affecting Fruit Size, Quality, Return Bloom & Fruit Set

- Yellowing of Leaves
- Variable Bloom
- Defoliation (Japanese Beetle Damage)
- Bitter Pit
Literature...

- Related to yield and vigor.
  - Mainly Crop Load
- Small optimum range 4-6 fruit per TSCA

Does leaf yellowing affect floral bud differentiation and therefore, return bloom? CROP LOAD EFFECT?
Honeycrisp

# of Fruit/TCSA vs Return Bloom

3 and 9 Year Old – Farm 100

3 year old.

9 year old.

4 to 6 Fruits per TCSA

Too much cropload = no return bloom

# Fruit/TCSA (cm²) 2004

Return Bloom Rating 2005
Honeyscrisp

# of Fruit/TCSA vs Return Bloom

Combined 3 and 9 Year Old – Farm 100

However, great variability
TREATMENTS

Honeycrisp Apple, 3 orchards; Randomized complete block design
5 treatments (4 trees/treatment); Crop load adjustment applied after June drop

High Crop Load (HCL)
~270
~4 Fruit / Spur
Natural cropping

Medium -High Crop Load (M-HCL)
~200
3 Fruit / Spur or Hand-spread

Medium Crop Load (MCL)
~140
2 Fruit / Spur or Hand-spread

Medium -Low Crop Load (M-LCL)
~70
1 Fruit / Spur or Hand-spread

Low Crop Load (LCL)
~30
1 Fruit / 2 Spur
Table 1. The influence of crop load adjustment at fruit set on production characteristics of Honeycrisp at the Belding site.

<table>
<thead>
<tr>
<th>Season</th>
<th>Defining Data</th>
<th>High</th>
<th>Medium</th>
<th>Med. High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 Fruit / Tree</td>
<td>111.1</td>
<td>89.3</td>
<td>67.0</td>
<td>30.3</td>
<td></td>
</tr>
<tr>
<td>2006 Fruit / TCSA</td>
<td>18.1</td>
<td>14.3</td>
<td>8.4</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>2006 Leaf to Fruit Ratio</td>
<td>8.6</td>
<td>12.9</td>
<td>26.6</td>
<td>35.0</td>
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<table>
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<tr>
<th>Season</th>
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</thead>
<tbody>
<tr>
<td>2006 Yield (kg/tree)</td>
<td>17.7 a</td>
<td>16.6 a</td>
<td>12.7 b</td>
<td>8.3 c</td>
<td></td>
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<tr>
<td>2006 Color pick (%)</td>
<td>55.4 a</td>
<td>65.0 a</td>
<td>78.7 b</td>
<td>95.2 b</td>
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<tr>
<td>2006 Drop (%)</td>
<td>13.1 a</td>
<td>8.1 a</td>
<td>7.9 a</td>
<td>0.9 b</td>
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<tr>
<td>2006 Fruit weight (g)</td>
<td>170.5 a</td>
<td>189.0 a</td>
<td>229.2 b</td>
<td>252.9 c</td>
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<tr>
<td>2006 Fruit diameter (mm)</td>
<td>74.2 a</td>
<td>76.0 a</td>
<td>80.1 b</td>
<td>83.8 c</td>
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<tr>
<td>2006 Yellow (1 to 10)</td>
<td>2.5 a</td>
<td>3.5 a</td>
<td>3.8 a</td>
<td>4.0 a</td>
<td></td>
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<tr>
<td>2006 Bitterpit (%)</td>
<td>1.6 a</td>
<td>2.6 a</td>
<td>1.6 a</td>
<td>3.3 a</td>
<td></td>
</tr>
</tbody>
</table>

| 2007 Return Bloom* (0 to 10) | 1.9 | 2.6 | 4.1 | 6.8 |
| 2007 Return Crop** (0 to 5) | 1.0 | 1.2 | 2.2 | 3.2 |
| 2007 Yellow** (0 to 10) | 1.9 | 2.1 | 1.6 | 1.2 |
| 2007 Bitterpit** (0 to 10) | 0.9 | 1.6 | 2.0 | 2.3 |
| 2007 Vigor** (1 to 3) | 2.0 | 2.0 | 2.3 | 2.1 |

Means between row followed by the same letter are not significantly different at P = 0.05 by Tukey's.

*Visual Rating 8-May 2007
** Visual Rating 4-Sept 2007
Return Bloom Evaluation -- Wittenbach
Crop Potential Based on Presence of Flowers

2006 Crop Load Treatment
### 1997 Orchard

#### 2006 Crop Load Treatment

<table>
<thead>
<tr>
<th>Season</th>
<th>Defining Data</th>
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<th>Medium</th>
<th>Med. Low</th>
<th>Low</th>
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</thead>
<tbody>
<tr>
<td>2006 Fruit / TCSA</td>
<td>32.8</td>
<td>22.4</td>
<td>22.9</td>
<td>13.4</td>
<td>9.2</td>
<td></td>
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<tr>
<td>2006 Leaf to Fruit Ratio</td>
<td>3.3</td>
<td>6.6</td>
<td>8.5</td>
<td>22.1</td>
<td>37.0</td>
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<th>Low</th>
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<tr>
<td>2006 Yield (kg/tree)</td>
<td>20.8 a</td>
<td>20.0 a</td>
<td>19.4 a</td>
<td>15.2 b</td>
<td>10.8 b</td>
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<tr>
<td>2006 Color pick (%)</td>
<td>30 a</td>
<td>25.0 a</td>
<td>27.0 a</td>
<td>45.8 a</td>
<td>85.2 b</td>
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<td>2006 Drop (%)</td>
<td>37.2 a</td>
<td>36.8 a</td>
<td>20.2 a</td>
<td>26.2 a</td>
<td>8.9 b</td>
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<td>2006 Fruit weight (g)</td>
<td>132.2 a</td>
<td>151.2 a</td>
<td>175.8 b</td>
<td>177..7 b</td>
<td>184.8 b</td>
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<td>2006 Fruit diameter (mm)</td>
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<td>74.5 a</td>
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<td>77.4 b</td>
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<td>2006 Bitterpit (%)</td>
<td>4.6 a</td>
<td>7.8 a</td>
<td>5.8 a</td>
<td>3.2 a</td>
<td>13.8 b</td>
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<table>
<thead>
<tr>
<th>Season</th>
<th>Return Bloom* (0-10)</th>
<th>2.4</th>
<th>3.7</th>
<th>5.8</th>
<th>6.6</th>
<th>5.5</th>
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<td>2007 Return Crop** (0-5)</td>
<td>0.5</td>
<td>0.3</td>
<td>0.6</td>
<td>0.9</td>
<td>0.3</td>
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<tr>
<td>2007 Yellow** (0-10)</td>
<td>1.3</td>
<td>1.5</td>
<td>1.2</td>
<td>0.8</td>
<td>1.2</td>
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<tr>
<td>2007 Bitterpit** (0-10)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>2007 Vigor** (1-3)</td>
<td>1.6</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>2.1</td>
<td></td>
</tr>
</tbody>
</table>

Means between row followed by the same letter are not significantly different at P = 0.05 by Tukey’s.

*Visual Rating 8-May 2007

** Visual Rating 4-Sept 2007
The influence of crop load adjustment at fruit set on production characteristics of Honeyscrisp at the Sparta site.

## 2002 Orchard

<table>
<thead>
<tr>
<th>Season</th>
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<th>High</th>
<th>Med. High</th>
<th>Medium</th>
<th>Med. Low</th>
<th>Low</th>
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<tr>
<td>2006</td>
<td>Fruit / TCSA</td>
<td>15.7</td>
<td>8.1</td>
<td>6.2</td>
<td>2.4</td>
<td>1.9</td>
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<td>2006</td>
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<td>10.4</td>
<td>16.1</td>
<td>25.4</td>
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## 2006 Crop Load Treatment

<table>
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<tr>
<th>Season</th>
<th>Resulting Data</th>
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<th>Med. High</th>
<th>Medium</th>
<th>Med. Low</th>
<th>Low</th>
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<tr>
<td>2006</td>
<td>Yield (kg/tree)</td>
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<td>b</td>
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<td>2006</td>
<td>Fruit weight (g)</td>
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<td>211.5</td>
<td>b</td>
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<td>2006</td>
<td>Fruit diameter (mm)</td>
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<td>82.5</td>
<td>b</td>
<td>84.8</td>
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<tr>
<td>2006</td>
<td>Bitterpit (%)</td>
<td>4.6</td>
<td>a</td>
<td>3.6</td>
<td>a</td>
<td>9.6</td>
</tr>
<tr>
<td>*2007</td>
<td>Return Bloom* (0-10)</td>
<td>1.9</td>
<td></td>
<td>3.3</td>
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<td>5.1</td>
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<td>2007</td>
<td>Return Crop** (0-5)</td>
<td>0.5</td>
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<td>1.1</td>
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<td>1.2</td>
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<td>2007</td>
<td>Yellow** (0-10)</td>
<td>1.8</td>
<td></td>
<td>1.8</td>
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<td>1.0</td>
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<tr>
<td>2007</td>
<td>Bitterpit** (0-10)</td>
<td>0.0</td>
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<td>0.0</td>
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<td>0.0</td>
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<td>2007</td>
<td>Vigor** (1-3)</td>
<td>1.4</td>
<td></td>
<td>1.5</td>
<td></td>
<td>1.7</td>
</tr>
</tbody>
</table>
CLASS DISTRIBUTION

![Graph showing the distribution of crop load and yellow rating with data points and curves representing yield and yellow rating.]
PROBLEM
Leaf Yellowing

Literature...

• Related to accumulation of sugar and starch in slow growing shoots.
• More evident in low cropping trees.

Does leaf yellowing affect floral bud differentiation and therefore, return bloom? NO
Honeycrisp

# of Fruit/TCSA vs Return Bloom

3 and 9 Year Old – Farm 100

Return Bloom Rating 2005

# Fruit/TCSA (cm²) 2004

4 to 6 Fruits per TSCA

Too much cropload = no return bloom
Fruit Diameters by Fruit per TCA for 3 Orchards in 2007, NW Michigan

- 9 yr M26 (Gregory)
- Log.(9 yr M26 (Gregory))

R² = 0.360
% Return Bloom of Trees in 2007 Crop Load Study in 3 Orchards of NW Michigan

- 9 yr M26 (Gregory)
- Log(9 yr M26 (Gregory))

R² = 0.420
Fruit Diameters by Fruit per TCA for 3 Orchards in 2007, NW Michigan

13 yr Bud 9 (Evans)

Log.(13 yr Bud 9 (Evans))

R² = 0.539
% Return Bloom of Trees in 2007 Crop Load Study in 3 Orchards of NW Michigan

- 13 yr Bud 9 (Evans)
- Log(13 yr Bud 9 (Evans))

$R^2 = 0.404$
Crop load

Negatively related to size
Negatively related to yield
Negatively related to return bloom
Return bloom is variable, even if thinned to 4-6 fruit/TCA
Negatively related to Yellowing
Yellowing is not effect fruit quality
Yellowing is positively related to return bloom
Time of thinning study

• Does time of thinning effect
  – Return Bloom?
Fruit load by thinning date

Fruit per TCSA (cm²) of 'Honeycrisp' trees thinned at different dates, CHES 2007.
The effect of time of thinning on return bloom on Honeycrisp, CHES 2007-2008

(thinning done by hand 1 fruit per spur)
Bitterpit greater than 10% for fruit 2.75 inch and up
BITTERPIT
Fruit size is related to bitterpit

Distribution of Bitterpit Occurrence in Size Classes
CROP LOAD

- Great variability in the 4-6 fruit per TCA range
- Why?
  - Could it be related to either seed # or fruit size.
  - Could GA produced by the seed be effecting return bloom.
  - It is well known that GA applied before FBI, inhibits flowering.

How could we study the effect of seed number?

- It has been reported that king fruit and lateral fruit have different seed numbers.

- We initiated an experiment to alter seed # by eliminating king fruit or lateral fruit.
KING VRS. LATERAL FLOWER?
KING FRUIT
Mean Fruit Weight per Seed Count for 'Honeycrisp' Apple
Prillwitz 2008

Number of Seeds per Fruit

Fruit Weight (g)

Fruit Weight (lb)

Lateral
King
Fruit size in lateral and king fruit in relation to seed number

Number of Seeds per Fruit and Fruit Diameter in 'Honeycrisp' Apple, CHES, 2008
The effect of fruit position on seed number

@ CHES 2007

Lateral- v. Terminal-Blossom Fruits by Seed No.
Comparison between number of seeds when actual cluster locations are considered

![Graph showing comparison between number of seeds when actual cluster locations are considered. The graph plots the mean number of seeds per fruit against the number of fruits. The x-axis represents the mean number of seeds per fruit (0, 1-2, 3-4, 5-6, 7-8, 9-10, >=11), and the y-axis represents the number of fruits (0 to 40). The graph includes lines for Lateral as Tmt, King as Tmt, Lateral adjusted, and King adjusted.](image-url)
Number of Seeds per Fruit and Fruit Diameter in 'Honeycrisp' Apple, CHES, 2008
Comparison of seed number to occurrence of bitter pit, CHES, 2008
THE EFFECT OF SEED NUMBER

- Seed number is greater in lateral fruit.
- Fruit size is larger with increased seed number.
- Lateral fruit are larger than king with the same number of seeds.
- What is the relationship between seed number and return bloom?
- Apple seeds produce GA.
- GA inhibits Flower Bud Initiation.
  - Does seed number inhibit return bloom, if so since Honeycrisp produced large fruit, can we inhibit seed number?