Exclusion nets: a step towards pesticide-free apple growing in North America
Growing organic apples is difficult in NE North America…
But how about growing without pesticides?

- If key pests can be controlled
- If diseases do not flare up
- If climate extremes are not too challenging
- If pollination can be achieved
Exclusion systems exist for tree fruit
7-yr study 2012-2018

• Assess the effectiveness of a complete exclusion system for the prevention of apple fruit damage
  – Without using any pesticide or other sprays
  – On a ‘Honeycrisp’ high-density planting
  – Exclusion nets in place from bud-break to harvest

• Improve our knowledge of:
  – Primary and secondary pests and diseases, non-parasitic disorders
  – Photosynthesis and fruit quality
  – Pollination within / below nets
  – Nets and structure: strength, durability, ease of opening
Setup

• Cv. Honeycrisp / B9 (planted 2006)
• Zero sprays (no pesticides, growth regulators, fertilizers)
• Each plot: 10 m (12 trees)
• Compared treatments (6X):
  1) nets*
  2) No nets

*ProtekNet 60g/m clear HDPE
  – mesh: 0,95x1,9mm
  – light transmission: 93%
Collected data

- Fruit damage (insects, diseases and non-parasitic)
- Foliar pests populations
- Temperature and photosynthesis
- Fruit load and quality (color, size, firmness, sugars, etc.)
Installation - spring
Complete exclusion
Opening (for summer work)
Opening (for pollination)

2012: 40 h
2013: 24 h
2014: 19 h
2015: 20 h
2016: 24 h
Visited flowers

- Opened nets do not affect pollination behavior

**Visits /100 Flowers**

- **2014**
  - **Apis mellifera**
  - Other hymenopteran pollinators
  - Other pollinators

- **2015**
  - Two open nets
  - Open Exclusion net
  - Check (no nets)
Fruit pests (2012-2016)
(120 apples/unit, picked < 1 week from harvest)

Average % damage at harvest

<table>
<thead>
<tr>
<th>PC</th>
<th>AM</th>
<th>CM</th>
<th>EAS</th>
<th>TPB</th>
<th>LR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>****</td>
<td>***</td>
<td></td>
<td></td>
<td>****</td>
</tr>
</tbody>
</table>

No nets
Nets

Leafroller damage – 2012-2016

(Choristoneura rosaceana, Obliquebanded leafroller)
Summer arthropods (2012-13-16)
(various population indices, pests and beneficials)

- Leafhoppers
- Twospotted mite
- Red mite
- Rust mites
- Aphids
- Stigmaeid mites
- Phytoseid mites
- Aphid predators
- Ants

Average population levels

Legend:
- No nets
- Nets

* Indicates significant difference.
Fruit and foliar diseases (3-5 years)

(Various indices)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Average Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire blight</td>
<td>**</td>
</tr>
<tr>
<td>Foliar rusts</td>
<td>**</td>
</tr>
<tr>
<td>Foliar scab</td>
<td>*</td>
</tr>
<tr>
<td>Fruit scab</td>
<td>*</td>
</tr>
<tr>
<td>SBFS</td>
<td>*</td>
</tr>
</tbody>
</table>

* Nets vs No nets
Relative humidity – May-August

Average values in un-netted plots vs. Average values in netted plots

2015, 1 dot = 5-min average
Non-parasitic damage (2012-2016)
(120 apples/unit, picked < 1 week prior to harvest)

Average % damage at harvest:

- **Mechanical**
- **Russetting**
- **Asymmetry**
- **Hail**

Nets vs. No nets:

- *******}
- *****}
- ****}
- ****}

*(120 apples/unit, picked < 1 week prior to harvest)*

Outil de formation du cueilleur de pomme
Photosynthesis and fruit quality (3-5 years)

(Various indices)

Average levels

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No nets</th>
<th>Nets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits/cluster set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maturity</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Firmness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeds/fruit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brix</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Crop load vs pollination time

# average fruitlets / cluster

2015

2014
Photosynthesis and fruit quality (3-5 years) (various indices)

- Chlorophyll/10
- Fluorescence (Fv/Fm)
- % red color
- Removed fruits/tree
- Fruit size (mm)
- Fruit weight (g)
- Yield (kg/tree)

Average levels

- Nets
- No nets
Air temperature – May-August

Average temperature in netted plots

Average temperature in un-netted plots

2015, 1 dot= 5-min average
Air temperature – May-August

May

June

July

August

September

October

Average temperature

Time of day

Nets

No nets
Air temperature - July

- **Temperature (°C)**

- **2013, 1 dot= 6-h average**

- **No nets**

- **Nets**
Seven years of pesticide-free Honeycrisp:

- Requires investment (11$/m/10yr)
- Requires additional labour for pollination (0.60$/m/open day)
- Complicates thinning / other sprays
- Protects fruit from insects - except for OBLR
- Protects from birds / mammals
- Protects from mechanical injuries and hail
- Does not result in scab epidemic
- Does not significantly affect tree physiology
- Produces high-quality fruit
- May slow down fruit maturity by up to ca. 1 wk
Protection from BMSB

First catch in Québec apple orchards: June 2014

First established population detected in Montreal, August 2016
Acknowledgments

- **Organisationnal support:**
  - IRDA - Quebec Apple Network
  - CETAB +
  - Université Laval
  - Polytechnique Montreal

- **Financial support 2012-2018:**
  - CAAP (Canadian Agricultural Adaptation Program)
  - Organic science cluster II (AAAC)
  - Innov’action (MAPAQ)
  - Québec Apple Growers
  - Dubois Agrinovation (nets)