Mechanical Harvesting of Southern Highbush Blueberries and Postharvest Disease Relationships

- Part of comprehensive 4-year research/extension project to take southern highbush production to next level
- **Main themes:**
  1. Overcome genetic, horticultural, and engineering barriers that stand in the way of mechanical harvesting for fresh market
  2. Improve overall fruit quality and microbial safety
  3. Address emerging systemic diseases that threaten the industry

Bill Cline
Mainland, C. M. et. al., 1975. The Effect of Mechanical Harvesting on Yield, Quality of Fruit and Bush Damage on Highbush Blueberry. J.A.S.H.S. 100:129-134

- Machine harvesting reduced yields of marketable fruit by 19 to 44%.
- 10 to 30% softer than hand harvested fruit.
- Machine harvested fruit developed 11 to 41% more decay after 7 d storage at 70°F.
- Sorting increased rots of mechanically harvested fruit by an additional 5 to 10%.

Slide courtesy Bill Cline, NCSU
Questions to be addressed as part of mechanical harvest component

- Compare standard cultivars to the new crispy-flesh cultivars such as *Sweetcrisp* and *Farthing*:
- Do the plants survive and produce well?
- Do they mechanical-harvest well?
- Can they be manipulated with fruit abscission chemicals to improve harvest?
- How much delay in harvest occurs with machine-harvest?
- How much ground loss occurs?
- **Does the fruit hold up well in storage? What are the impacts on microbial contaminants and postharvest disease?**
- Do consumers like the crispy flesh fruit?
- Will switching to partial mechanical harvest improve profit margin?
Potential disease/pathogen issues associated with machine-harvest

- **Bush damage**, especially at base of plant, due to harvester’s catch pans
  - Entry points for stem blight and canker pathogens
- **Fruit bruising** due to direct contact with harvester’s beater rods or as result of fruit falling in harvester
  - Increased susceptibility to postharvest decay
  - Potential attachment sites for microbial contaminants of food safety concern
Minimizing crown injury associated diseases

- Proper pruning, cultivar selection (narrow crown)
- Careful harvester operation
- More gentle catch pan designs (e.g. “centipede scales”)
Quantifying fruit bruising: Blueberry harvest impact sensor

BIRD (Blueberry Impact Recording Device)

Changying Li  Pengcheng Yu
BIRD (Blueberry Impact Recording Device)

BIRD sensor node

PC-BIRD software: data analysis

Downloading/recharging interface

PC-BIRD software: data acquisition

C. Li
BIRD (Blueberry Impact Recording Device) during mechanical harvest with Korvan 8000

- Blueberry interaction with rotary head and falling on the fisher scale
- Transportation on conveyor belt
- Falling on lug
Fruit firmness and machine-harvesting

- Berry firmness is key
- Conventional SHB cultivars such as Star, Emerald, Scintilla, Primadonna
  - Lower firmness than rabbiteyes
- Novel crisp-textured SHB cultivars
  - New focus of UF, NC, and UGA breeding programs
  - Firmer berries than conventional cultivars
    - E.g. Sweetcrisp, Farthing, Suzieblue

Machine-harvesting of crispy SHB cultivars may be feasible with reduced bruising and postharvest decay
Crispy berries, machine-harvest, and postharvest disease development

• Compare conventional and crisp-textured SHB genotypes after hand- or mechanical-harvest in relation to:
  1. microbial contamination on fruit at harvest
  2. subsequent postharvest decay development

• Identify fungal organisms associated with postharvest decay
Cultivars and harvesting (Waldo, FL)

- **“Conventional” type**
  - FL 01-248, Primadonna (2009)

- **“Crispy” type**
  - FL 98-325 (2009)

4 replicate row sections

Cold storage for 0, 7, 14, and 21 days, room temp for 4 days
### Natural disease development in cold storage

![Graph showing fruit disease incidence (%) over days in cold storage.](image)

<table>
<thead>
<tr>
<th>Source</th>
<th>2009</th>
<th>2010</th>
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<tbody>
<tr>
<td></td>
<td>ndf</td>
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<tr>
<td>Harvest (H)</td>
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</tr>
<tr>
<td>T×F</td>
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<td>164</td>
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<tr>
<td>T×H</td>
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<td>164</td>
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<tr>
<td>T×F×H</td>
<td>3</td>
<td>164</td>
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Disease incidence in relation to firmness

- Inverse relationship
- In 2009, >220 g/mm associated with low disease
- In 2010, firmness reached desired levels only in few cases
Contribution by different fungal genera

- *Alternaria* spp., *Cladosporium* spp., and *Aureobasidium pullulans* most common
- Complex of fungi similar across treatments
- Higher proportion of *Colletotrichum* in 2010

Data from all 4 cultivars over 4 assessment dates
**Cladosporium spp. and Aureobasidium pullulans**

- *Cladosporium* infection limited to velvety mycelial tuft visible at stem scar or cracks near scar
- *A. pullulans*: wet and slimy appearance of berries

Images courtesy Wharton & Schilder
Alternaria, Botrytis and Colletotrichum spp.
Microbial fruit surface contaminants

- Overall contaminant counts (aerobic bacteria, yeast, mold) below commonly used thresholds for processed blueberries
- No effect of harvest method or flesh type
- No *E. coli* detected in either year
- Coliforms detected in:
  - One rep of hand-harvested Primadonna in 2009 (avg. 7 CFU/g)
  - Machine-harvested reps of Farthing and Sweetcrisp in 2010 (avg. 1 and 20 CFU/g, respectively)
Conclusions

- No significant effect of flesh type and harvest method on microbial contaminants
- **Natural decay incidence:** Lower for hand-harvested fruit; for crispy flesh type
- Machine-harvested crispy flesh equal to or lower than hand-harvested conventional flesh
- Fruit firmness good predictor of post-harvest decay; >220 g/mm desirable
- *Cladosporium, Alternaria, and Aureobasidium* most common
- **Artificial inoculation:** Lower decay incidence for crispy flesh

Machine-harvested crispy SHB acceptable in terms of postharvest disease and quality
Overall Bottom Line from Mechanical Harvesting Experiments

• For most quality and postharvest attributes, hand-harvested conventional and machine-harvested crispy equivalent
• Stay on top of optimal harvest window, avoid hot temperatures
• Field losses (ground drops) still problematic, but can be addressed with pruning, cultural practices, and breeding
• Economics: cautiously optimistic
Fresh-pack blueberry practices to reduce postharvest decay

- Select cultivars for resistance, dry stem scar, crispy fruit
- Use preharvest fungicides
- Timely, thorough harvest (every 4-7 days for highbush, 7-10 day for rabbiteye)
- Handle berries dry
- Provide a clean pick/pack environment
- Cool (dry) pre-pack followed by forced air

Slide courtesy Bill Cline, NCSU
Exobasidium Leaf and Fruit Spot (*Exobasidium* sp.)