Managing blueberry quality with ground covers and harvest strategy

Sheng-yang Li, Michael Gasdick, **Josh Vander Weide (jvander@msu.edu)**
Department of Horticulture, Michigan State University

Steve Van Timmeren, Rufus Isaacs
Department of Entomology, Michigan State University

Project Timelines

#	Title	2022	2023	2024	2025
1	Replanting Issues (BRD)		■	■	■
2	NH Blueberry Variety Trial				■
★ 3	Ground Covers		■	■	■
4	Pulsed Irrigation			■	■
5	Berry Maturity and Yield Prediction		■	■	
5	Uniformity of fruit quality		■	■	
6	PGRs	■	■	■	
★ 7	Delayed Harvest		■	■	

Ground covers are a long-term management decision

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Best Practices for Replanting Blueberries in Michigan

Josh Vander Weide, Department of Horticulture, Michigan State University
Mike DeGrandchamp, DeGrandchamp Farms, South Haven, Michigan
Bill Groenink, MBG Marketing, Grand Junction, Michigan

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Blueberry Varieties for Michigan

Josh Vander Weide[a], Rufus Isaacs[b], Timothy Miles[c], Pat Edger[a], Cheyenne Sloan[d], and Carlos Garcia-Salazar[d]
[a] Department of Horticulture, Michigan State University
[b] Department of Entomology, Michigan State University
[c] Department of Plant, Soil, and Microbial Sciences, Michigan State University
[d] Michigan State University Extension

Background on ground covers in blueberry production

1. Wood mulch is the current grower standard, and aids with weeds and drainage.
2. Reflective mulch increases light in the canopy.
   - One study showed that reflective mulch increased yield in **potted** blueberry (Petridis et al., 2019).
3. Black weed mat may increase temperature in the canopy.
   - One study showed an increase of >5 °C compared to mulch.

1. Wood mulch (WM)

2. Black weed mat (BM)

3. Reflective mulch (RM)

https://www.goodfruit.com/reflective-mulch-proves-repellent/

Objectives and Hypotheses

- ***Horticulture***
  - **Objective 1. Determine whether ground cover treatments affect photosynthesis.** *Hypothesis 1: Black weed mat and reflective mulch will increase canopy photosynthesis rate due to warmer or brighter canopy conditions.*
  - **Objective 2. Characterize the impact of ground cover treatments on fruit composition.** *Hypothesis 2: Warmer or brighter canopy conditions will improve berry size and quality.*

- ***Entomology***
  - **Objective 3. Compare insect pest (SWD) populations for blueberries grown over ground cover treatments.** *Hypothesis 3: Ground cover treatments significantly reduce key insect pests compared to wood mulch.*

Materials and Methods

- Trevor Nichol's Research Station (Fennville, MI)
  - Mature 'Bluecrop' field

Photosynthesis Light Response Curves

- Collected at four phenological stages:
  - Bloom (June, 14, 2024)
  - Mid-ripening (June, 27, 2024)
  - Harvest (July 12, 2024); Post-harvest (October, 2024)
- A_{sat}, I_{sat}, I_{comp}, and *Rd*, derived from fitted model

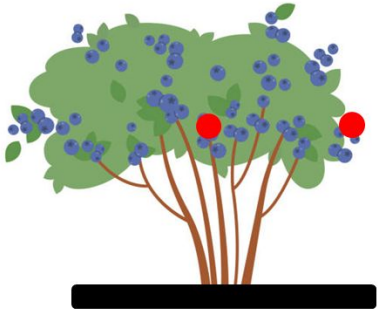
Lobo et al., 2013
doi: 10.1007/s00442-014-2988-5

PAR and UV-A/B, -C Light; Temperature

- Collected at three phenological stages:
  - Bloom (June, 14, 2024)
  - Mid-ripening (June, 27, 2024)
  - Harvest (July 12, 2024)
- Sensor positions: 🔴
  - Inner canopy up/down
  - Outer canopy up/down

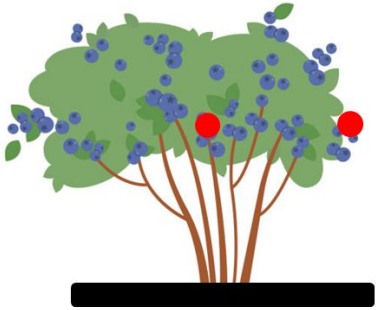
Harvest fruit composition analyses

- Fruit size
- Fruit firmness
- TSS/pH/TA
- Flavonoid composition
- Aroma volatile composition



Canopy light conditions

- Compared to WM, RM increase PAR reflected up into the canopy center by **57%** across years.
- Compared to WM, RM increase UV-A/B reflected up into the canopy center by **160%**.



Photosynthesis light response curves

- A_{sat} was higher in RM than WM at mid-ripening, harvest, and post-harvest.
- Photosynthesis rates were maintained in RM and BM.

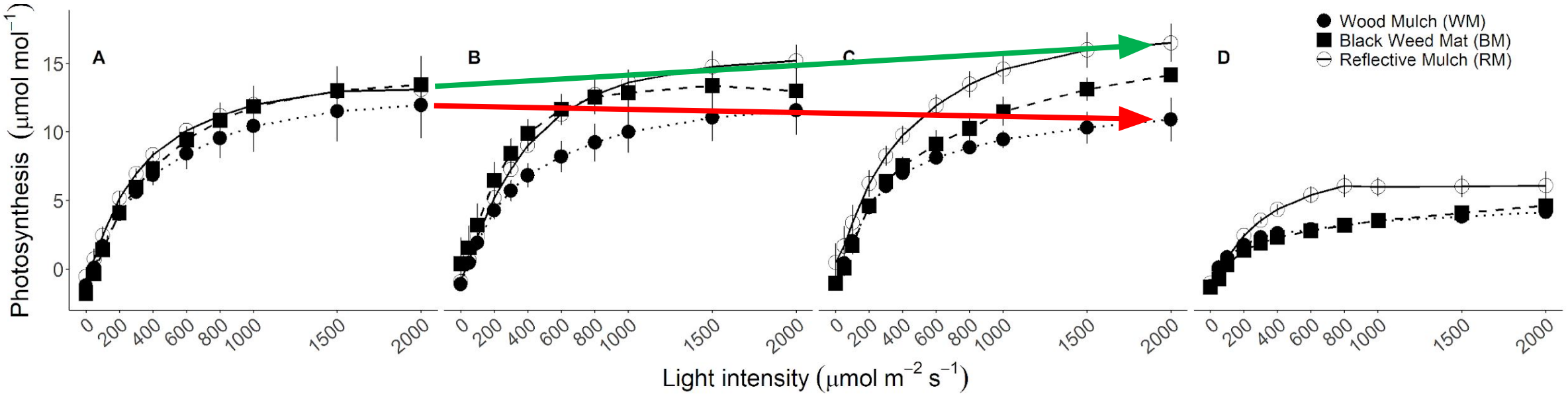


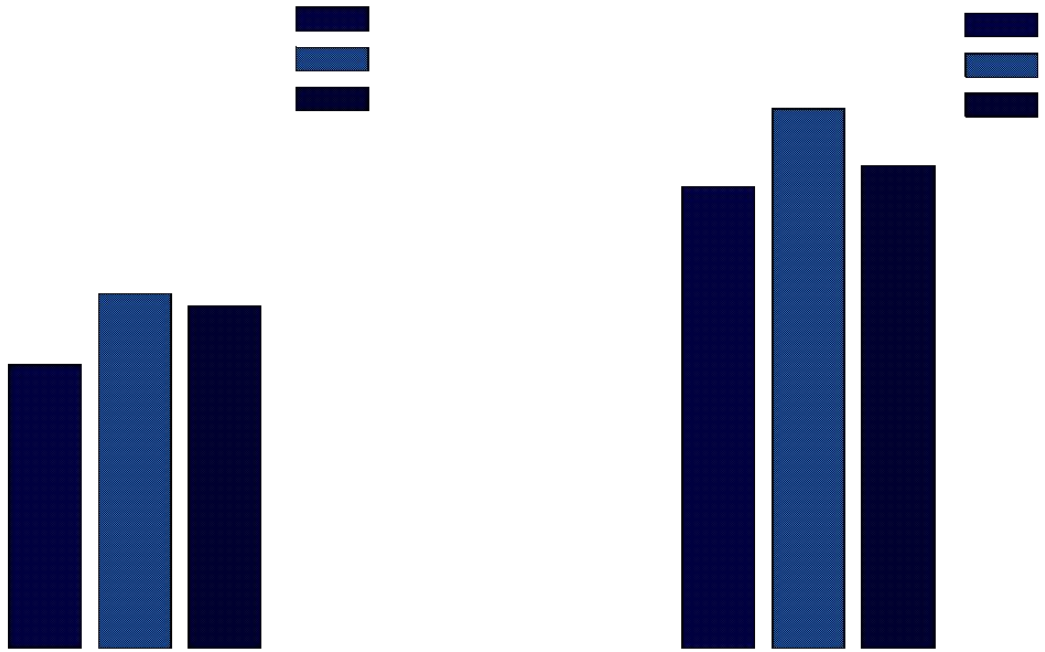
Figure 2. Photosynthesis light response curves collected from ground cover treatments at A) bloom, B) mid-ripening, C) harvest, and D) post-harvest.

Berry Mass & Firmness

- In year 1, RM increased berry mass compared to MW, but no effect was observed in year 2.
- In year 1, BM and RM increased firmness compared to WM, but no effect was observed in year 2.

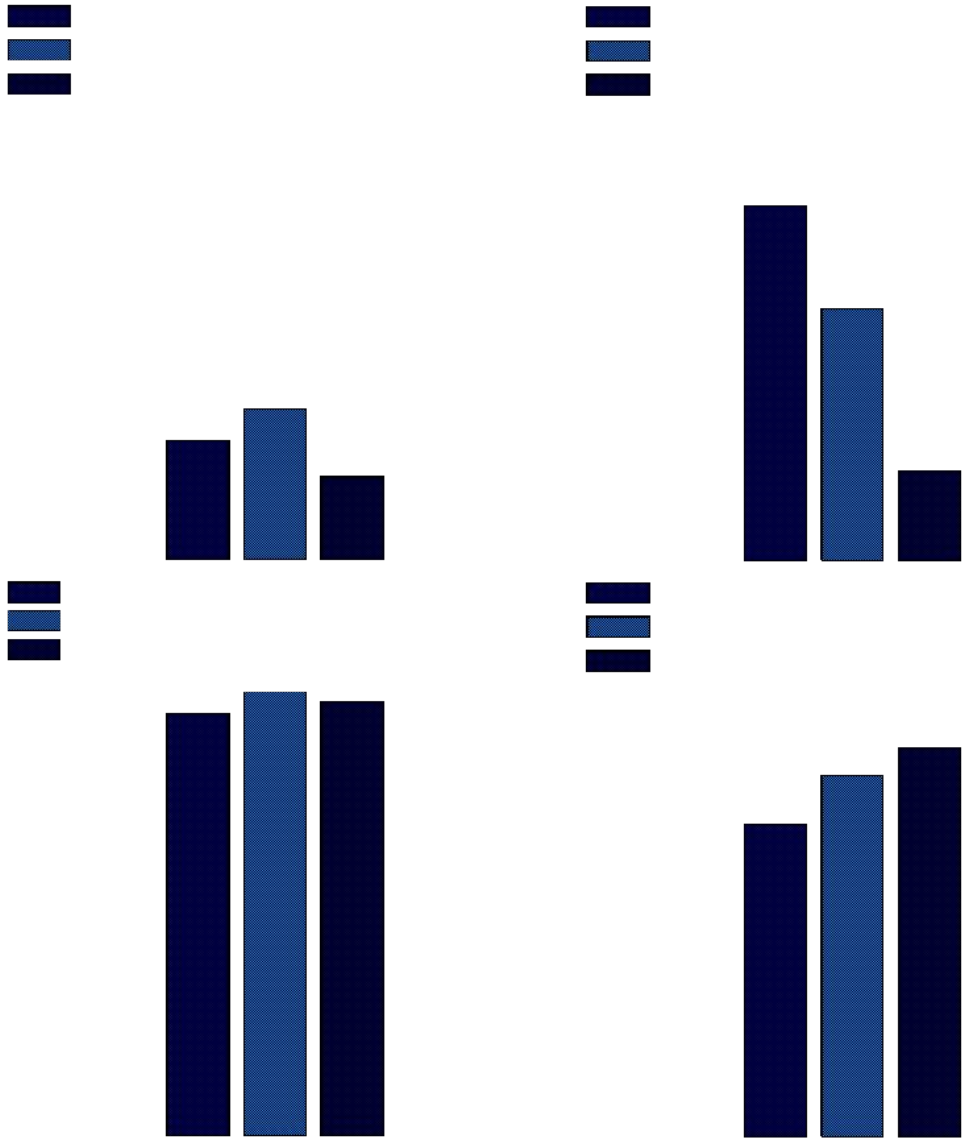
Berry TSS/TA

- BM and RM increased TSS/TA compared to WM in year 1 (due to higher TSS), but no differences were observed in year 2 (greater TA loss).



Berry Color & Anthocyanins

- RM decreased the percentage of berries with red backs by over 75% from WM. This may be due to the warmer ripening period in year 2.
- RM significantly increased anthocyanin concentration by 24% compared to WM in year 2.



Fruit Rot Development

- Ground covers did not impact the development of Colletotrichum spp. during incubation.
- RM decreased the development of Botrytis cinerea by over 50%.

SWD

- SWD did not differ among treatments in the top third of the canopy (warm, dry conditions).
- SWD was reduced by BM and RM compared to WM in the bottom third of the canopy (cool, moist conditions).

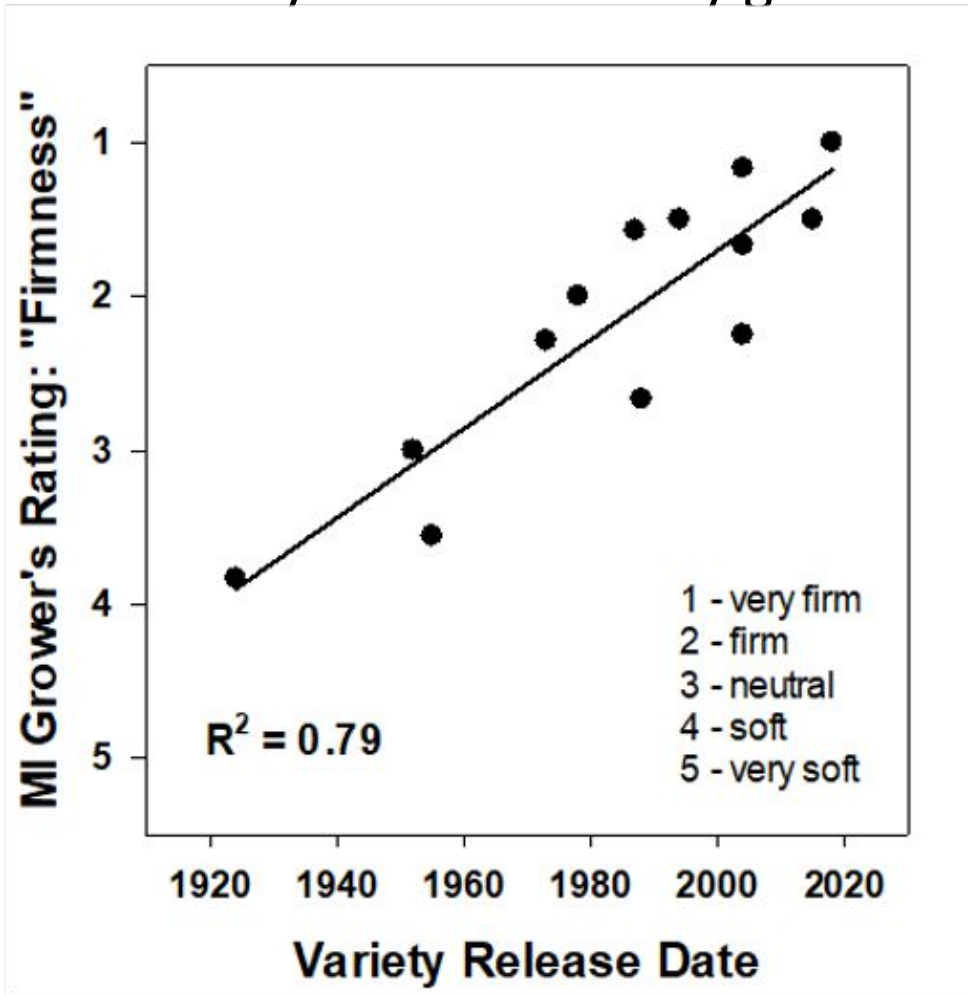
Conclusions

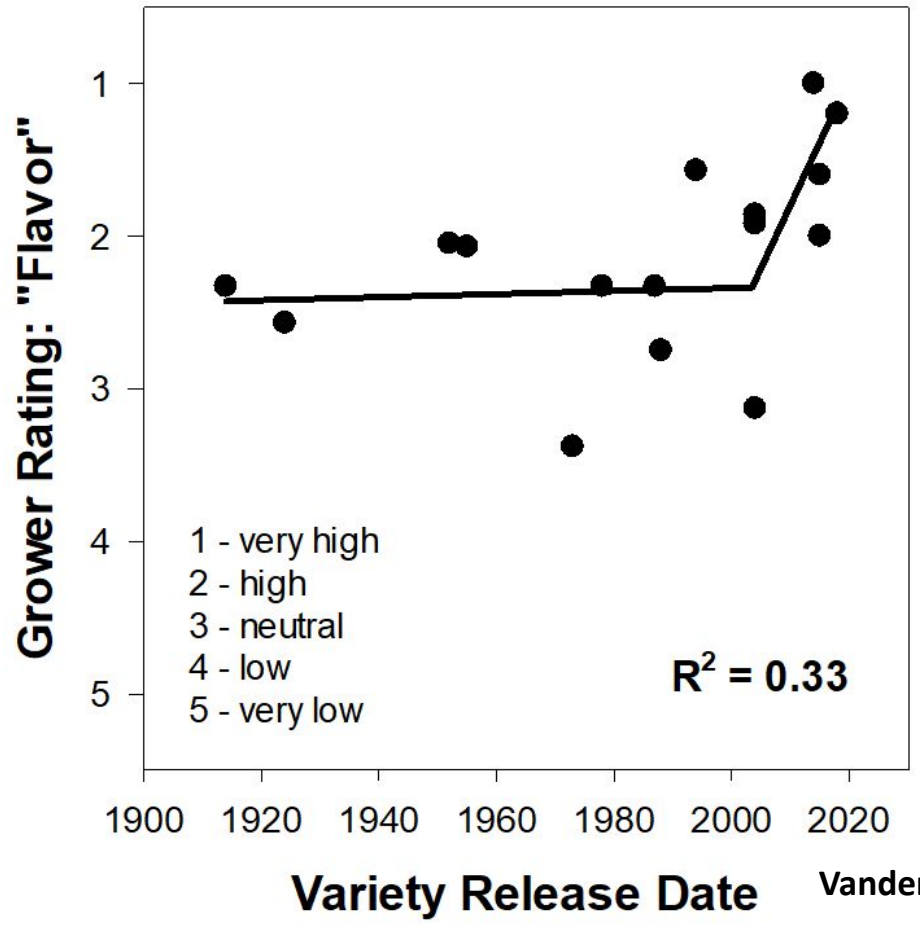
1. RM increased photosynthesis levels compared to WM.
2. Fruit quality was altered by BM in year 1, but not by any treatment in year 2.
3. RM reduced botrytis development compared to WM and BM.

4. **Growers should try reflective mulch in place of black weed mat.**
   - Certain cultivars and conditions (high tunnel) increase red backs (decreases pack out).
   - Certain cultivars (‘Draper’) are highly susceptible to *Botrytis*.
   - Most mid/late and late season cultivars are susceptible to SWD.

Improving blueberry flavor

- 2022 Survey of MI blueberry growers (~40% of industry).





VanderWeide et al. 2023

Objectives and Hypotheses

- ***Horticulture***
  - **Objective 1. Determine cultivar-specific suitability for delayed harvest based on fruit firmness.**
  - **Objective 2. Identify optimal harvest percentage for each cultivar based on firmness and flavor.**

- ***Sensory Science***
  - **Objective 3. Assess whether consumer panelists can detect differences in texture and flavor across delayed harvest treatments.**

Cultivars

'Duke' – 1987 release

- High firmness
- Good flavor
- High yield

'Draper' – 2004 release

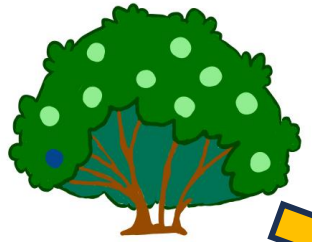
- Very high firmness
- Very good flavor
- High yield

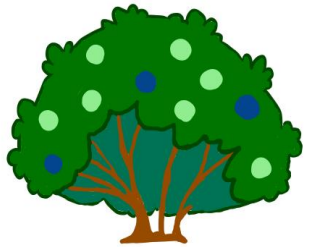
'Calypso' – 2015 release

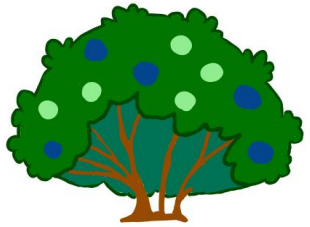
- Moderate firmness
- Good flavor
- High yield

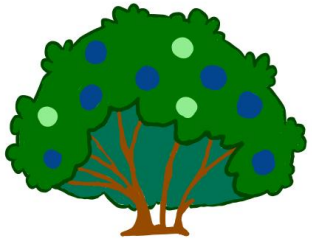
Delayed harvest treatment

1. **10%** blue fruit harvest
2. **30%** blue fruit harvest
3. **50%** blue fruit harvest
4. **70%** blue fruit harvest

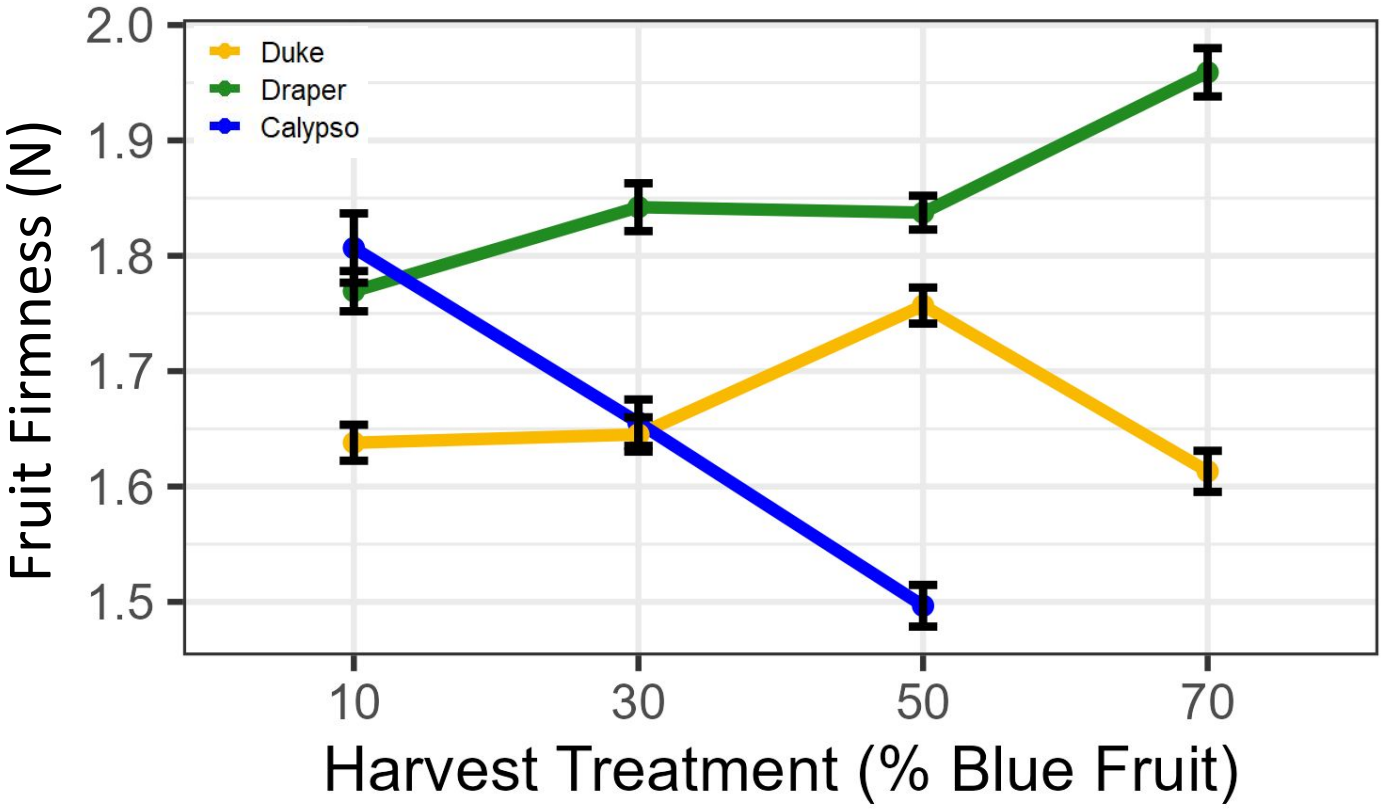








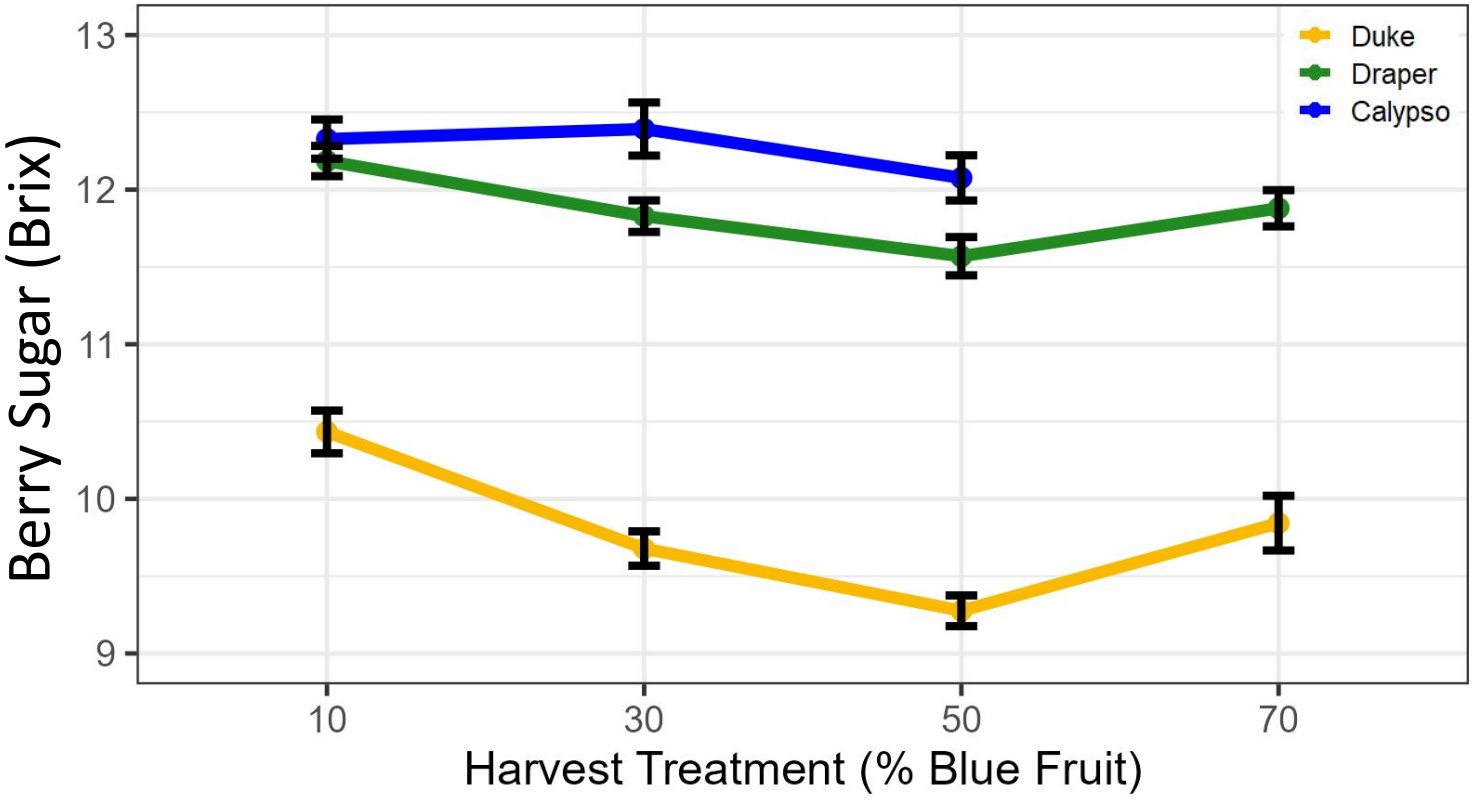
Berry Firmness



Ripening

- ‘Calypso’ berries lost firmness quickly while hanging, but ‘Duke’ and ‘Draper’ did not
- “Delayed harvest” candidates should not lose firmness before picking

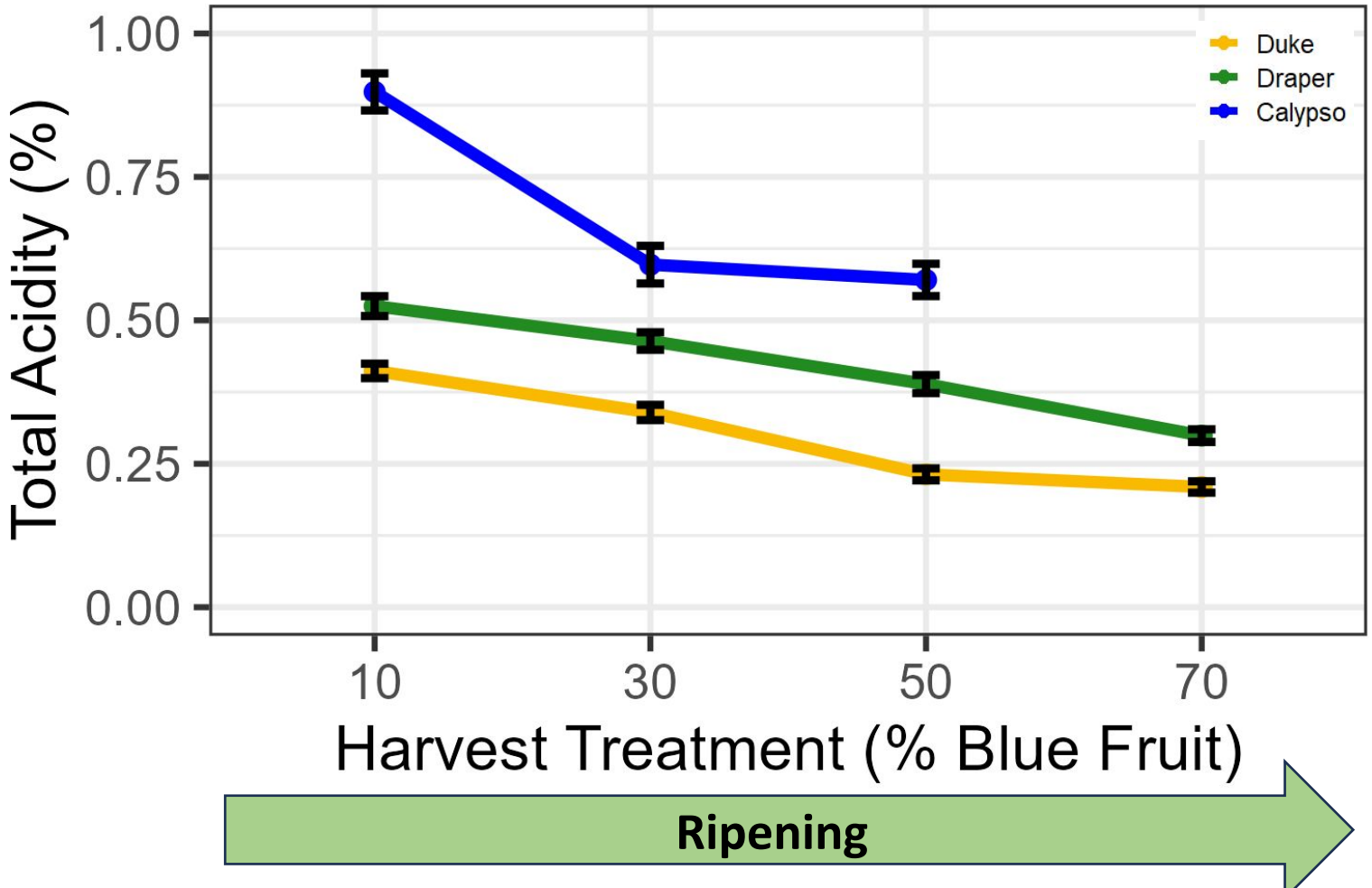
Berry sugar concentration



Ripening

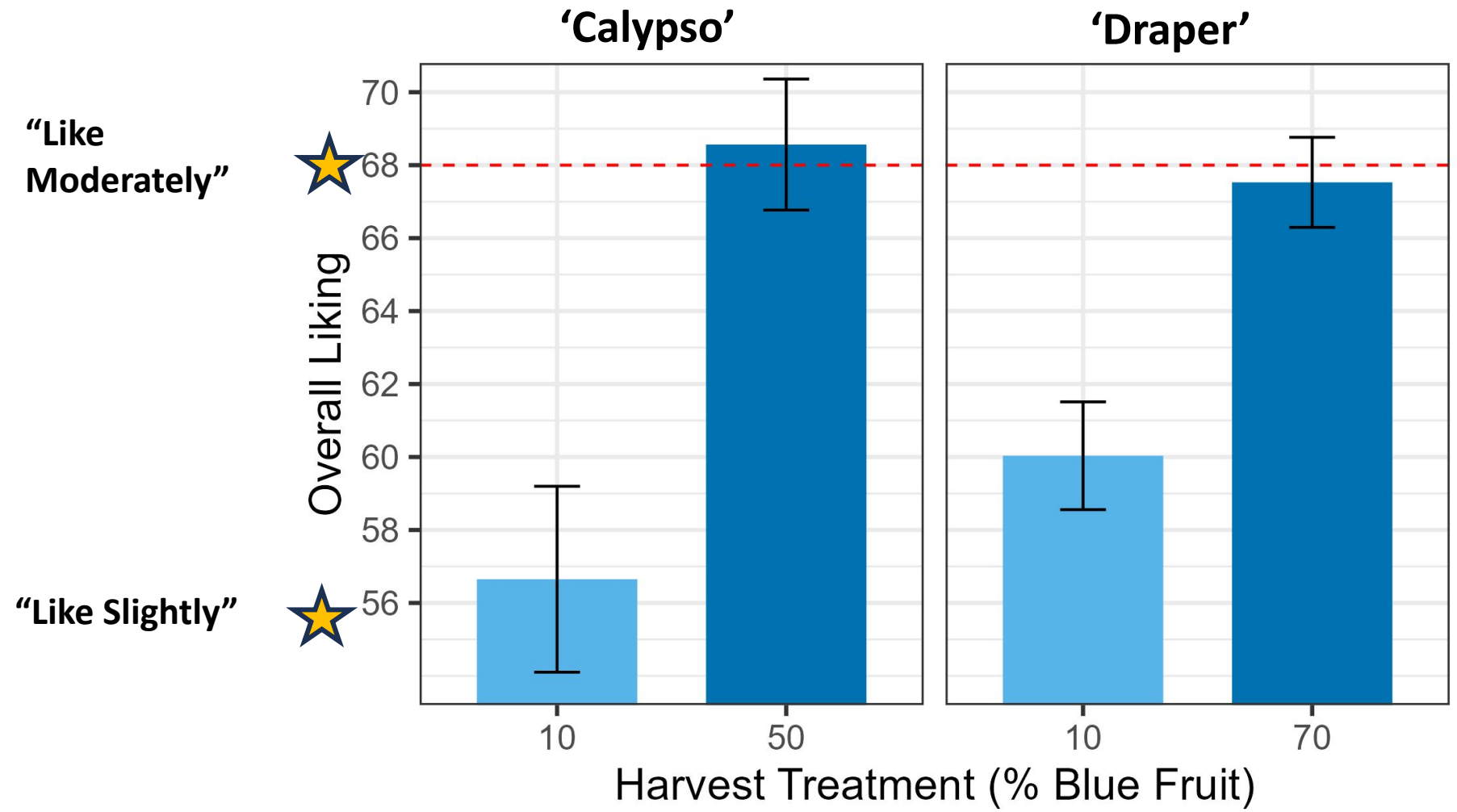
- Delaying harvest did not have a consistent impact on total sugars.
- ‘Duke’ had lower sugar than ‘Draper’ and ‘Calypso’.

Berry acidity



- Delaying harvest **decreased acidity** in all cultivars.
- 'Duke' had the lowest acid, and did not lose more after 50%.

Overall Liking



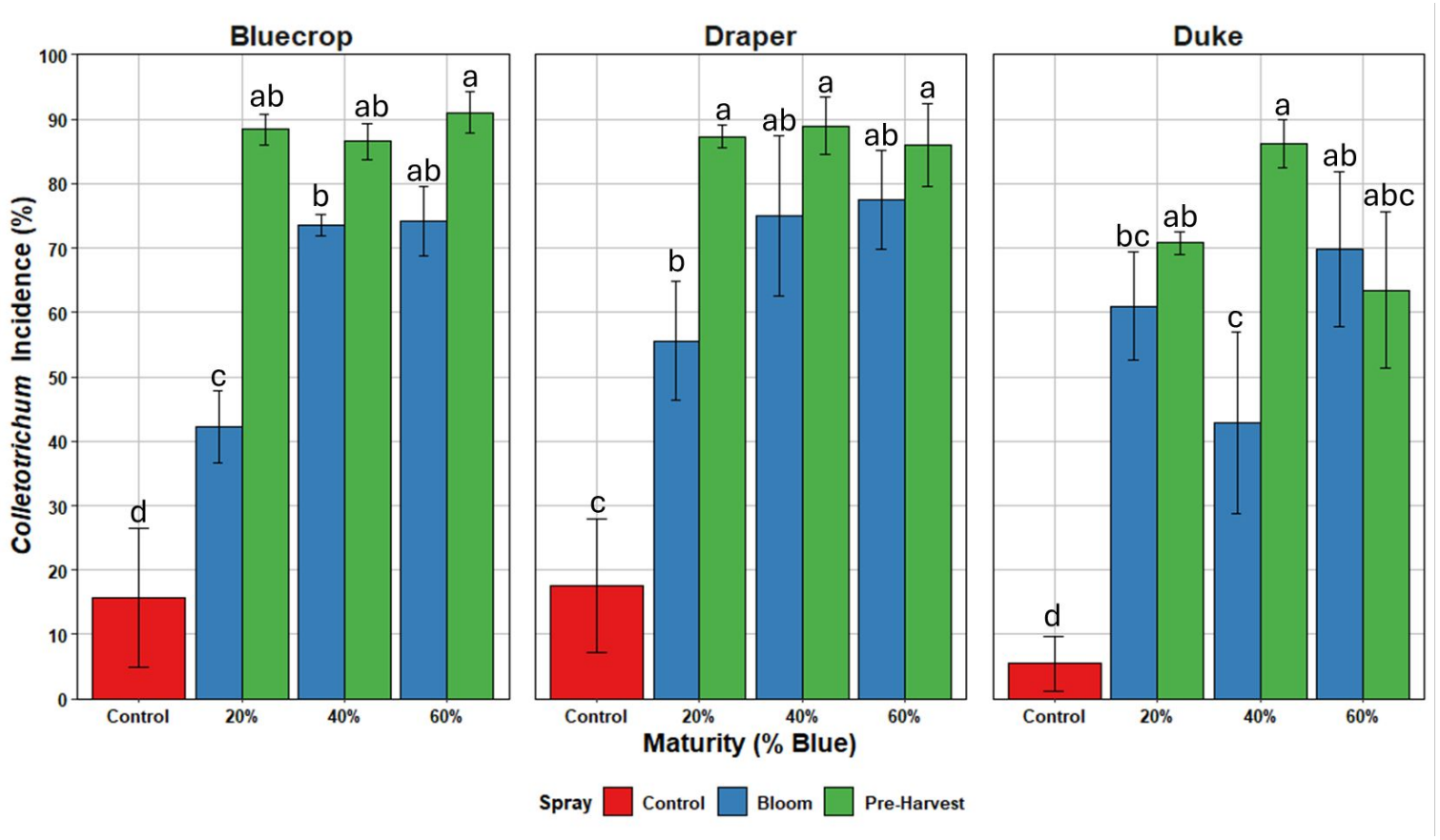
- Delaying harvest increased consumer liking from **"like slightly"** to **"like moderately"** in 'Draper' and 'Calypso'.
- "Delayed harvest" liking scores matched high-quality grocery store berries.

Caveats for “Delayed Harvest”

1. **SWD:** Use of delayed harvest should be dependent on SWD prevalence and IPM program.
2. ***Fruit rot:** We are conducting a study to determine whether fruit rot increases with delayed harvest.
3. **Fruit drop:** We did not observe fruit drop (birds, sprayers, etc.).
4. **Crop load:** Delayed harvest increases crop load and strain on canes. Delayed harvest works better in varieties with more "stocky" architecture, and when plants are not heavily pruned.

Colletotrichum sp. Incidence (%)

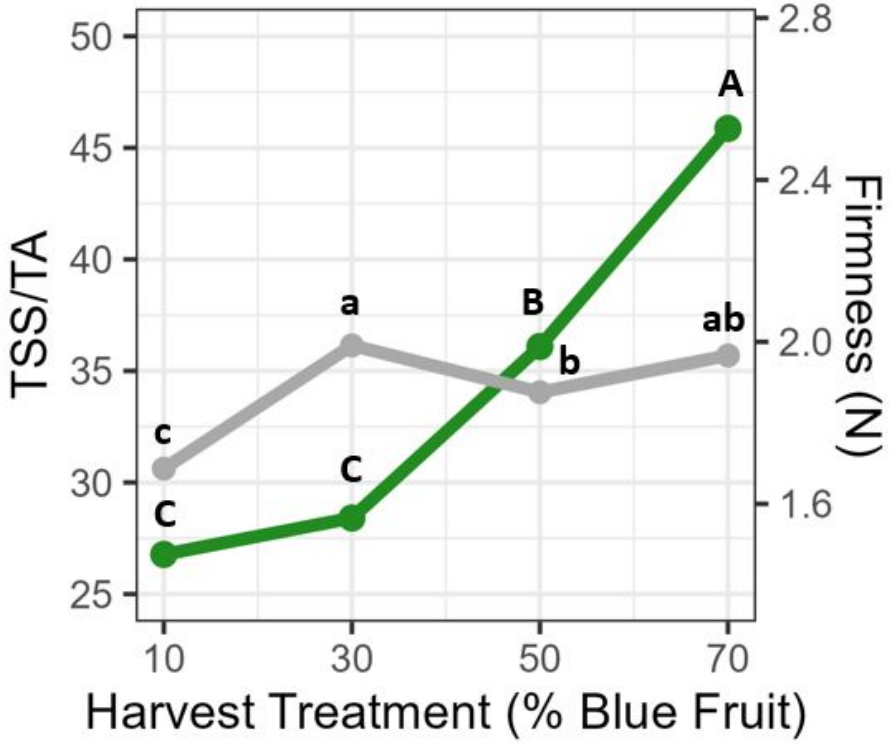
- Incidence did not increase with maturity (delayed harvest) for ‘Draper’ or ‘Duke’ when fruit were inoculated at either bloom or pre-harvest.



Conclusions

1. **Draper** did not lose firmness with hang time, and is a **great** candidate for delayed harvest.
2. **Duke** lost marginal firmness with hang time, and is a **good** candidate for delayed harvest.
3. **Calypso** lost firmness with hang time, and is **not a good** candidate for delayed harvest.

4. **Growers should test out scenarios where delayed harvest would be beneficial.**
   - To "buy time" with the harvest schedule.
   - To increase quality and flavor.



Thank you!

Project GREEEN

Ground Covers

- George & Bill Fritz – Brookside Farms
- Dan Dick

Delayed Harvest

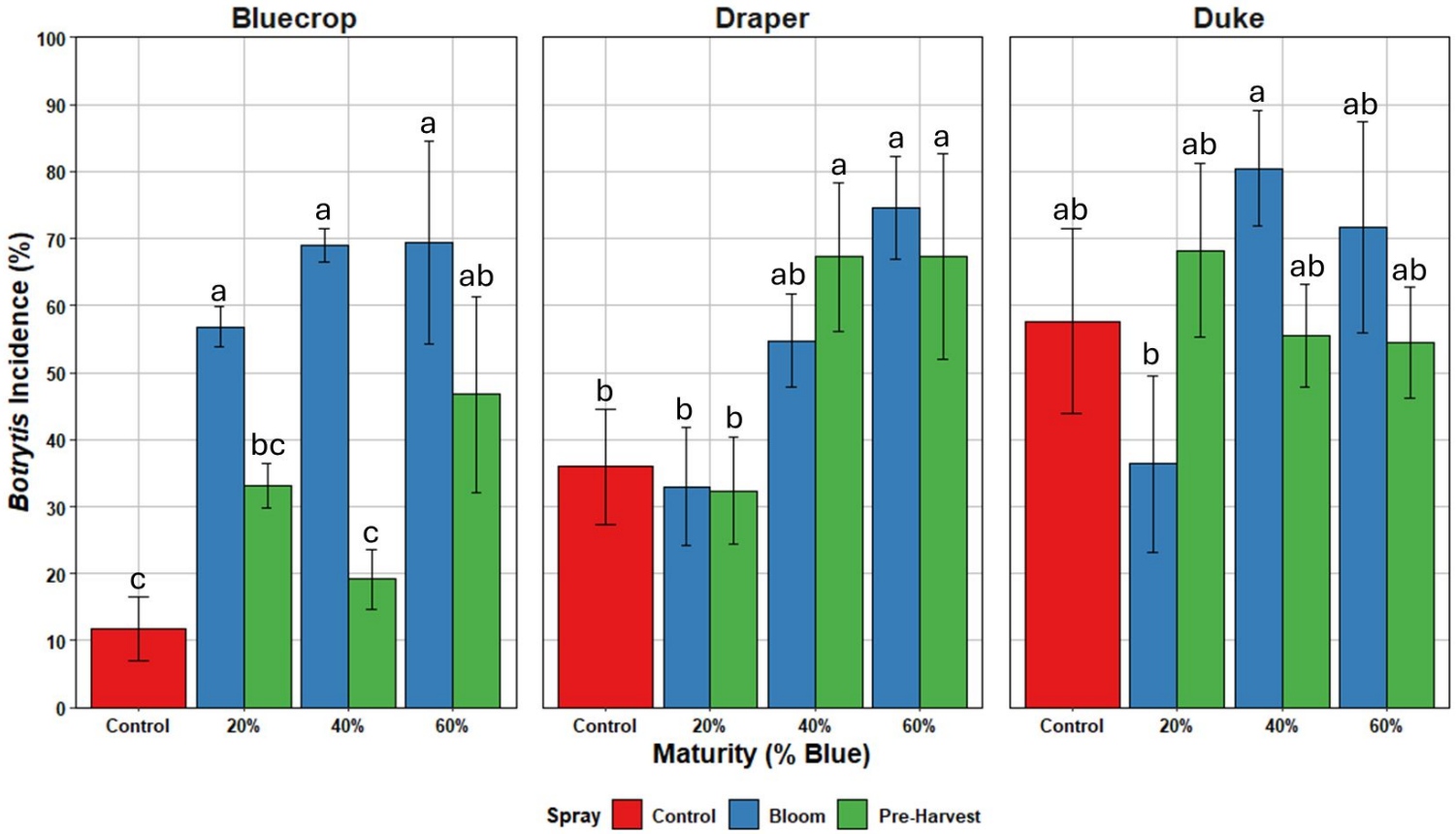
- George & Bill Fritz – Brookside Farms
- Cassandra Austin
- Dr. Emily Mayhew
- Lily Wei
- Aubrey DuBois

Questions?

Questions?

Botrytis cinerea Incidence (%)

- Inoculation at bloom in ‘Bluecrop’ increased botrytis across maturity.
- Botrytis incidence increased with harvest maturity regardless of inoculation time.



'BlueberryCounter' iPhone App

- Photosynthesis rates were maintained in RM and BM.

Light and temperature regulate plant growth & development

Light

- Photosynthesis fluctuates at low light levels, but becomes saturated at moderate and high light levels.

Temperature

- Photosynthesis is low at temperatures below 15 °C and above 35 °C, with an optimum (T_{opt}) between 20-30 °C.

Ground and Fruit Temperature

- BM raised ground temperature in both seasons. RM generally maintained a cool ground temperature.
- BM increased fruit temperature compared to RM by **19%**.

Outline

1. Ground Covers shape fruit quality

2. Harvest management influences fruit quality

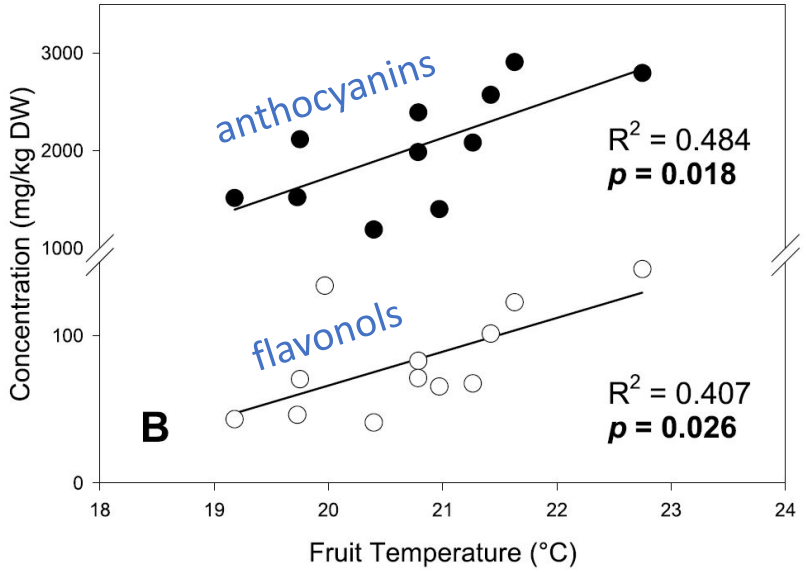
Light and temperature influence fruit quality

Light (fruit exposure)

- Limited impact on primary metabolites.
- Light stimulates secondary metabolite pathways (flavonoids: anthocyanins, flavonols; aroma volatiles: terpenes).

Temperature (fruit exposure)

- Large impact on primary metabolites: high/low temperatures increase/decrease sugars & acids.
- Smaller direct impact on secondary metabolites, indirectly related to maturity.

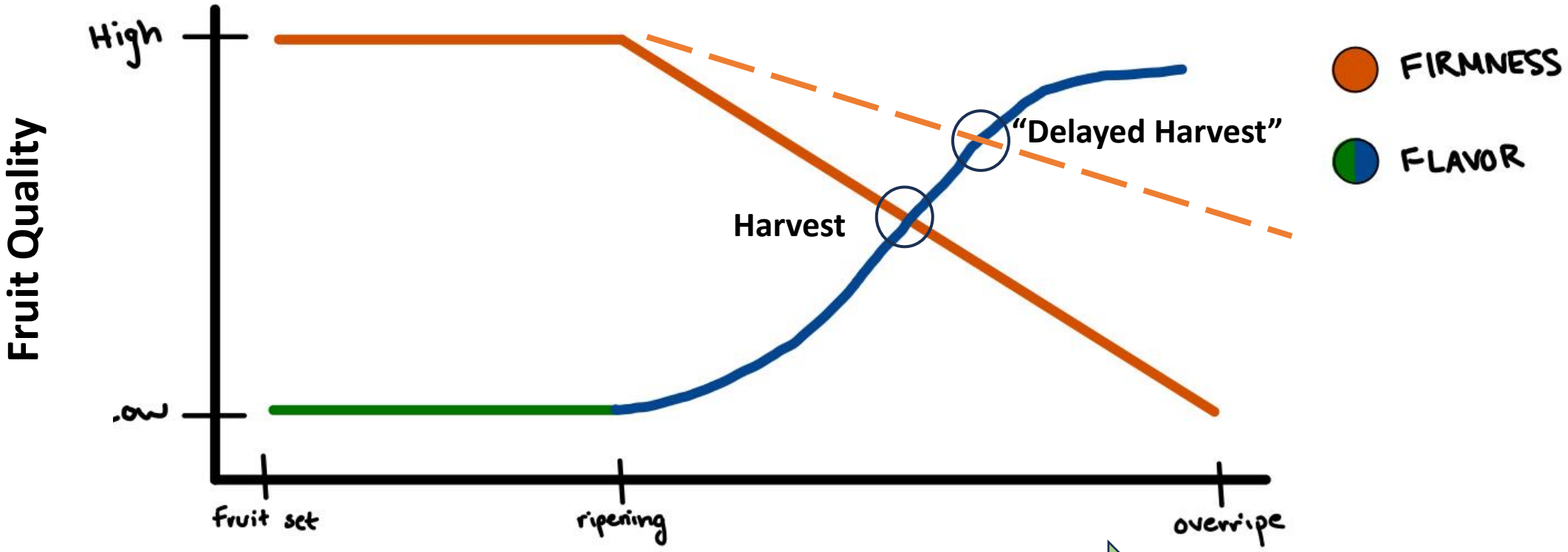


Vander Weide et al., 2024

Vander Weide et al., 2020

Relationship between firmness and flavor

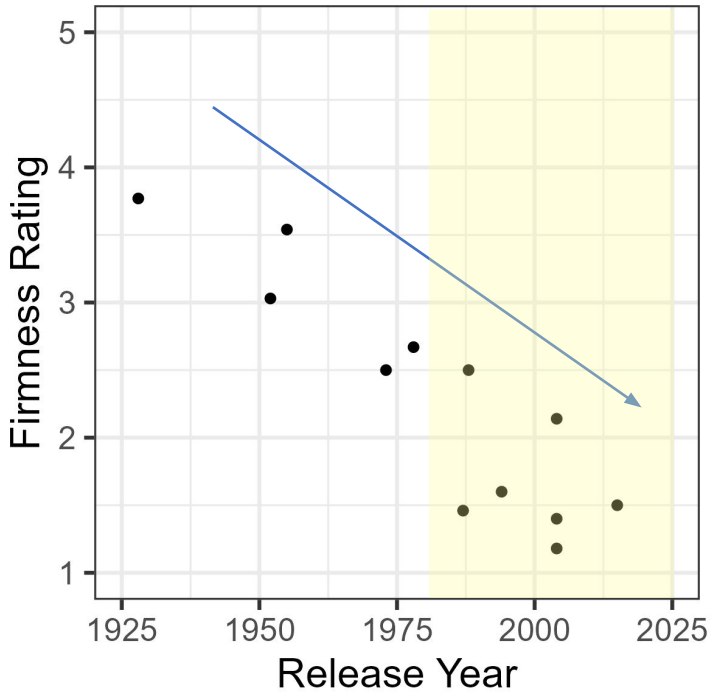
SWD

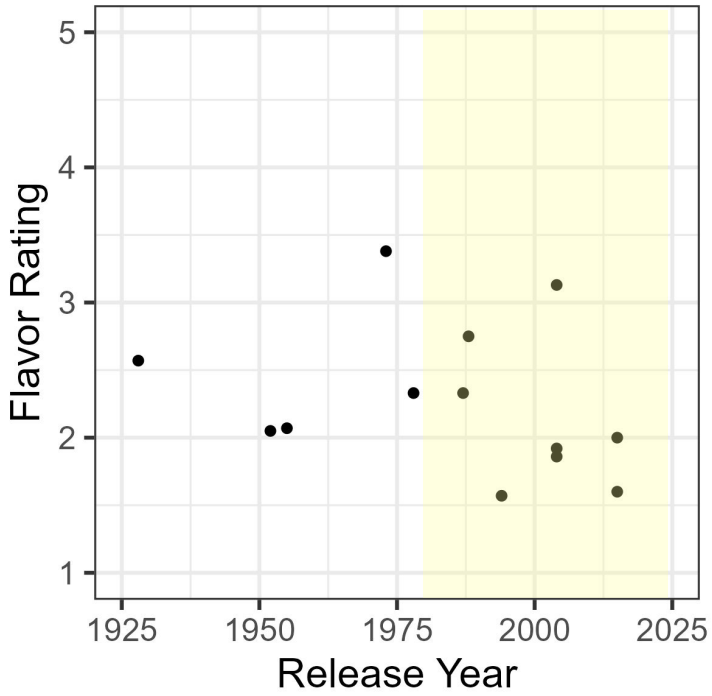


Hypothesis:
Delayed harvest should work better for "firm" varieties

New (firmer) cultivars = new implications for harvest management

- Firmness has historically been the priority of blueberry quality optimization.
- There are limited ways to improve blueberry flavor on established plants.





1 = Best
5 = Worst