Nursery Production of Containerized (Air Root Pruning) Trees: Advantages and Disadvantages

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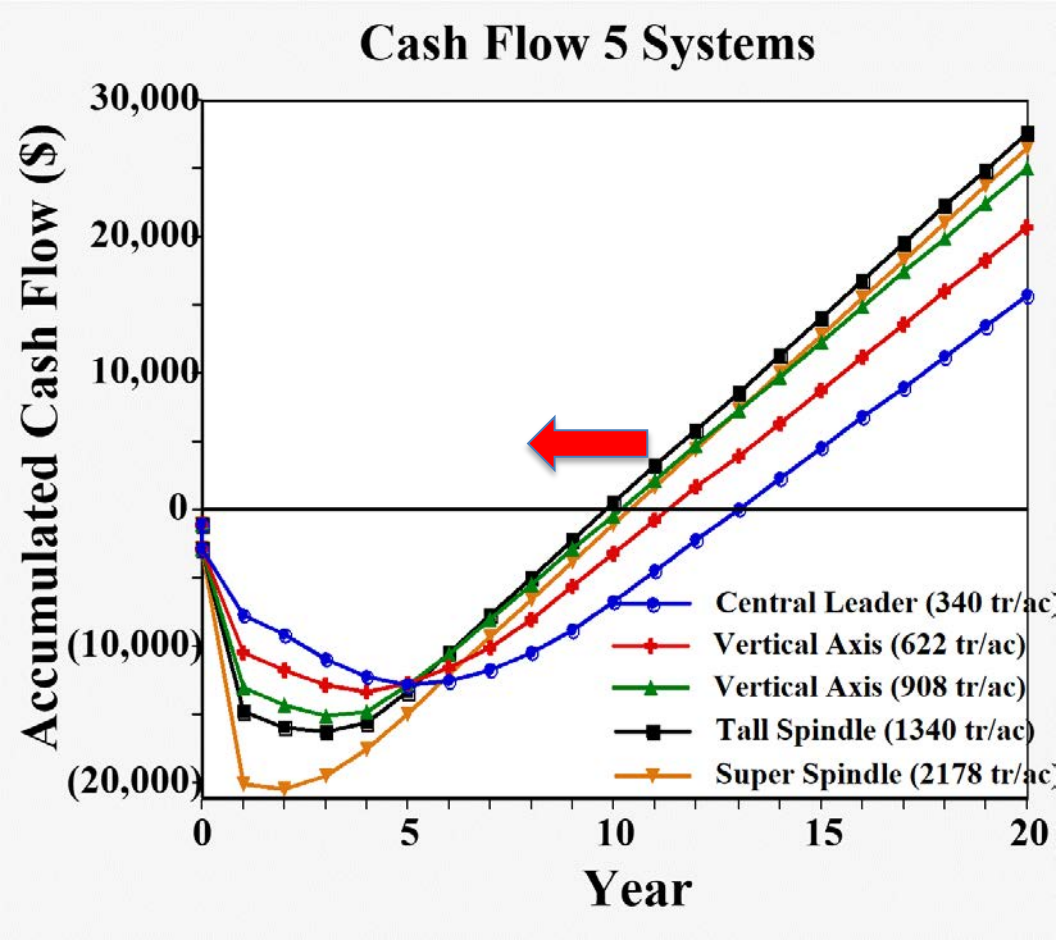
NEVF
New England Vegetable and Fruit Conference

Background/Rationale

- Planting density has steadily increased
- High-density plantings are expensive to establish
- First and second-leaf growth and development is critical to productivity and profitability over the life of the orchard

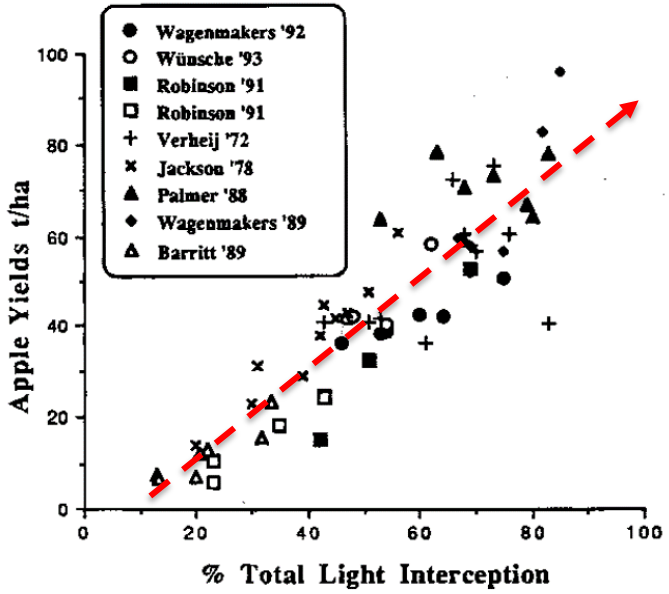
High establishment costs of high-density plantings necessitate a rapid ROI



Robinson et al., 2007

Background

- Returns paid for relatively low yields of high-value fruit in the second and third leaf only translate to profitability if canopy infill isn't negatively affected



Lakso, 1994

Issues with Planting Material

- Traditional bare-root nursery stock is inherently prone to transplant shock

Established spring, 2016

October, 2016

Are containers a viable alternative?

- Containers offer minimal disruption of the rhizosphere at planting
- The balance achieved in the nursery between above and below-ground growth is conserved
- Carbohydrate and nutrient reserves are available to promote early growth and establishment

Courtesy Dr. Bert Cregg

Management Advantages?

- Containers offer planting Flexibility
  - Spring planting vs. Fall planting
    - Opportunities to take advantage of H2A labor supply between harvests
  - Planting can be delayed if soil and climatic conditions are unfavorable
  - Container systems that keep the rhizosphere intact at planting (i.e., paper liners) expand the window for planting because of minimal disruption of the root system when not fully rooted in
  - Potentially, greater impact for inoculation of root systems with mycorrhizae

Container Diversity

- Containers differ widely in construction and concept
  - Plastic containers
  - Injection-molded materials
  - Paper liner/membranes

http://www.acwsupply.com/index.php/downloadable-catalog

Rootmaker products rootmaker.com

Ellepot products Ellepot.com

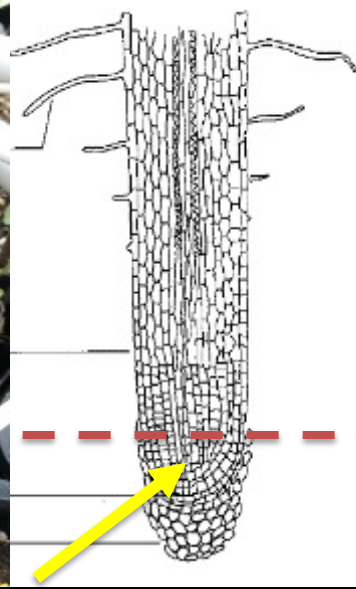
Container Root Systems

- Potential issues with container production
  - Circling roots
  - J-roots
  - Future Girdling
  - Poor spreading after establishment in field

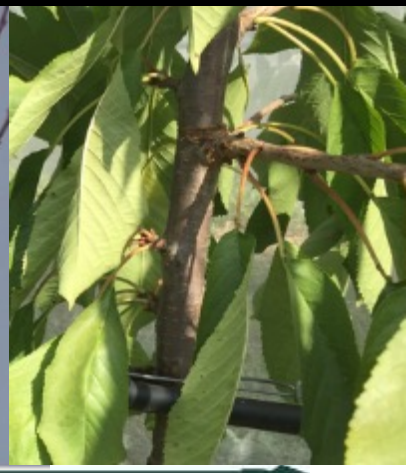
Courtesy Drs. Bert Cregg MSU & Alison Stoven O'Conner, CSU

Air Pruning Systems

- Air-pruning container systems
  - Encourage root branching by removing inhibitory signal for lateral root initiation
  - Increase root length density of fibrous (feeder) roots
  - Eliminate root circling and consequent girdling in future



Removal of apical meristem



Courtesy Lars Jensen

Cost Considerations

- Containerized trees have additional production costs
  - Media, molded trays, etc.
  - Freight/Shipping costs depend on origin, tree size, growth condition (i.e., 'green' or dormant)
  - Time in the nursery (1-year vs. 2-year-old tree)

Courtesy Cliff Beumel
Sierra Gold Nurseries

Ellepot System

Courtesy Cliff Beumel, Sierra Gold Nurseries

Planting Containerized Trees

Planting Containerized Trees

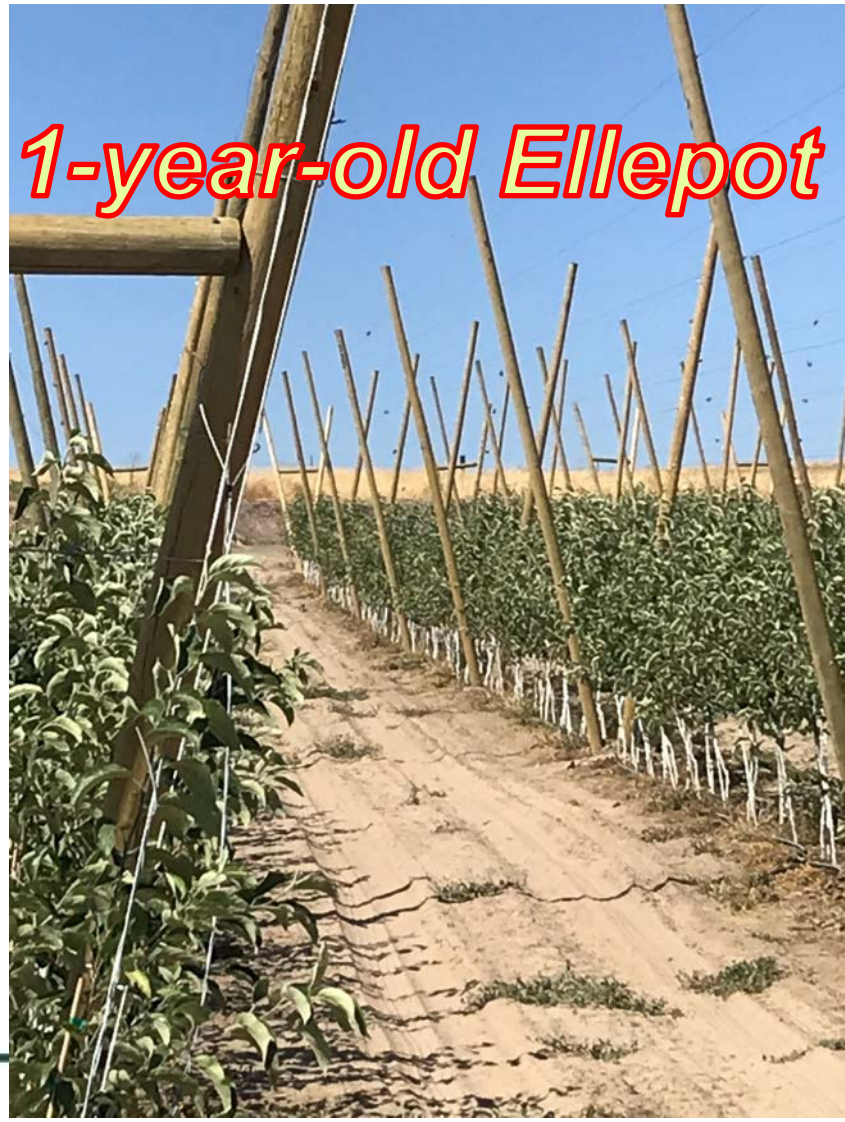
Courtesy Cliff Beumel, (Planting May 3, 2017 Yakima, WA)

Courtesy Cliff Beumel, (Same Planting October, 2017 Yakima, WA)

“Quick Start” Fuji on Bud 10
Side By Side with 2 Year Nursery Tree on M9
Planting Date June 1

Courtesy Cliff Beumel, Sierra Gold Nurseries

Yakima, WA: Planted mid May, 2019. Photos taken July 30, 2019



Courtesy Kit Johnson

Issues With Containerized Trees

- Trees that arrive 'green' require some form of acclimation prior to exposure to full light
- Production of feathers tends to be low
- One-year-old trees are small
  - There is a relationship between tree size at planting and cropping/profitability

On-farm nursery tree production- NY

Challenges With On-Farm Container Production

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- Given the small rooting volume, containers are *unforgiving* of horticultural errors
  - Water use (transpiration) and evaporative losses will exhaust container H_2O supply *daily*
  - Media offers relatively no buffering capacity
  - Knowledge of water quality is critical (pH adjustment)
  - Fertigate to match growth
  - Light and temp. management
  - Insulation/indoors in winter

2017 MSU Ellepot Production Trial

- Comparison of Bare root or Ellepot production systems for Honeycrisp, Gala, and Fuji on M9.Nic29 (starting material- bench grafts)

Ellepot Trials

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Front to back: Rep 1, Gala, Fuji, HC; Rep 2, HC, Fuji, Gala (obstructed)

Ellepot Trials

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Rep 3, Gala

Rep 3, Honeycrisp

Rep 3, Fuji

Ellepots Alter Canopy Growth

- A one-year nursery tree produced in air pruning containers was ~4 ft. tall when grown from a bench graft (slightly taller for Fuji, shorter for Honeycrisp)
- Container-produced trees were ***20-50% taller*** than field liners

Ellepot Trials

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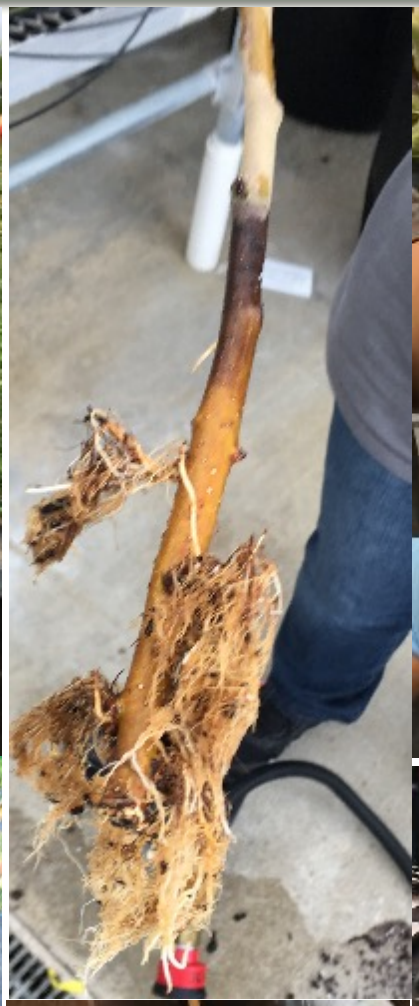

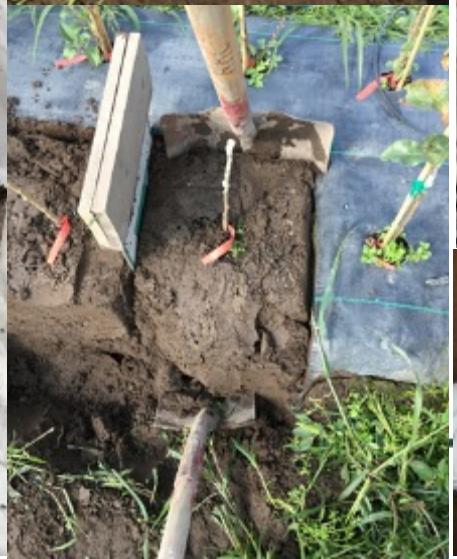

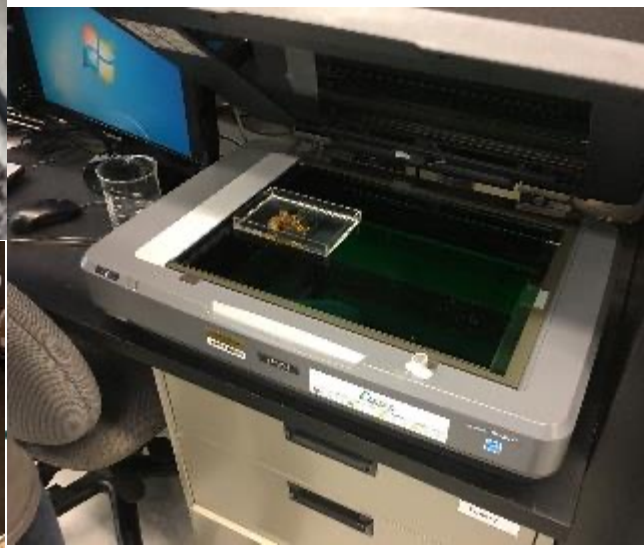

Root density of

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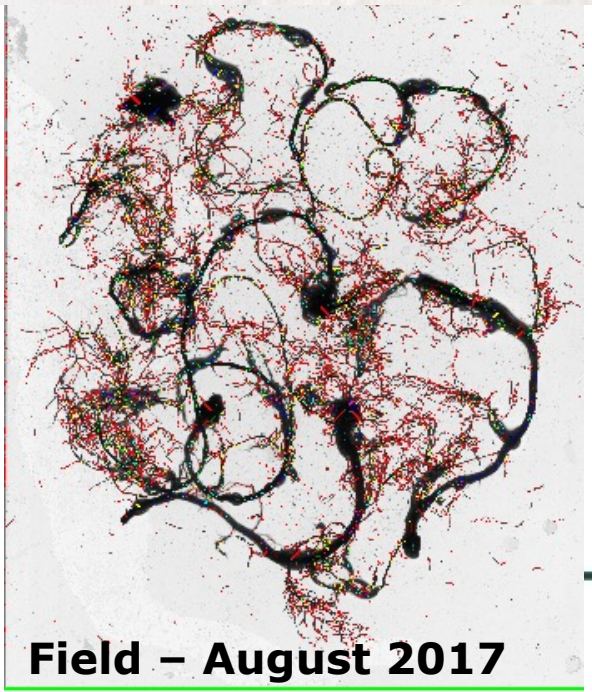
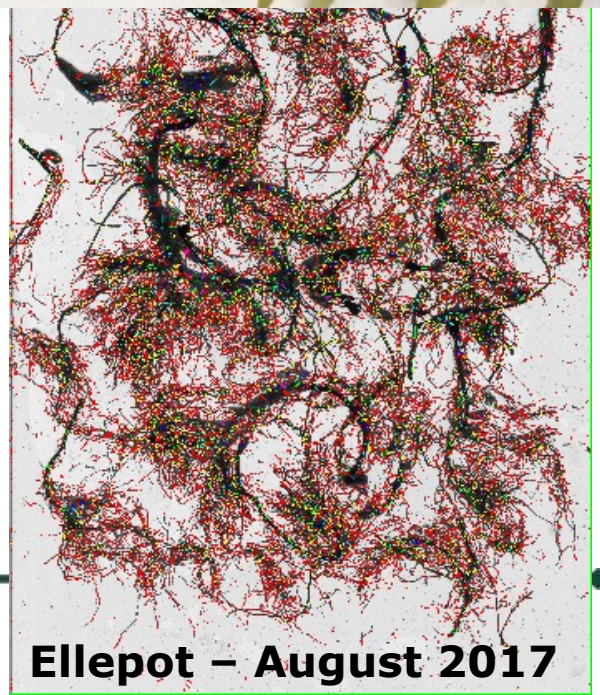
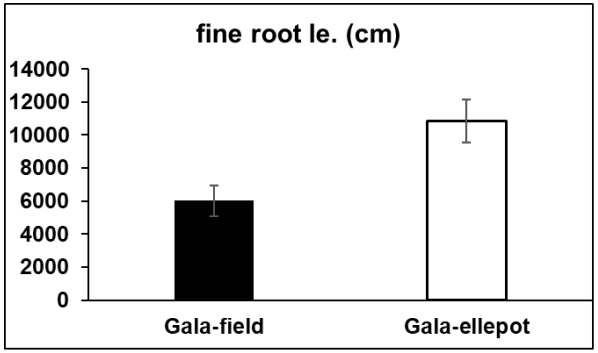
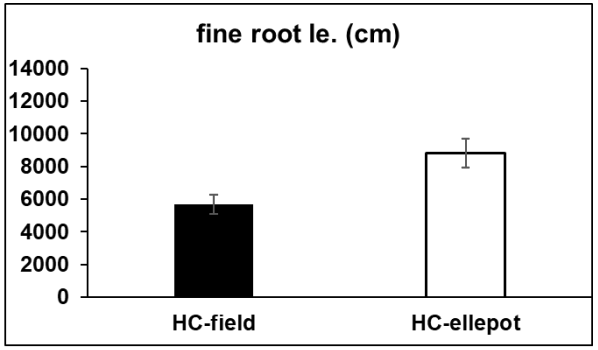
Ellepot vs. field produced apple

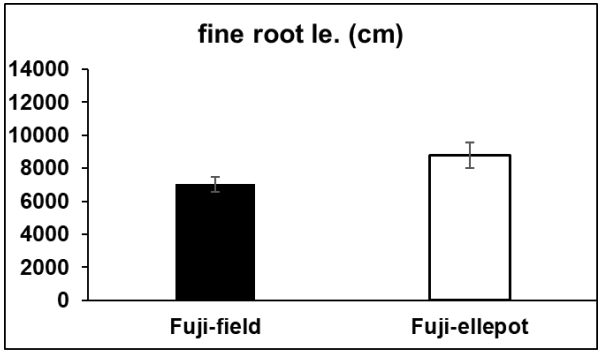




2017 End-of-season Root Growth

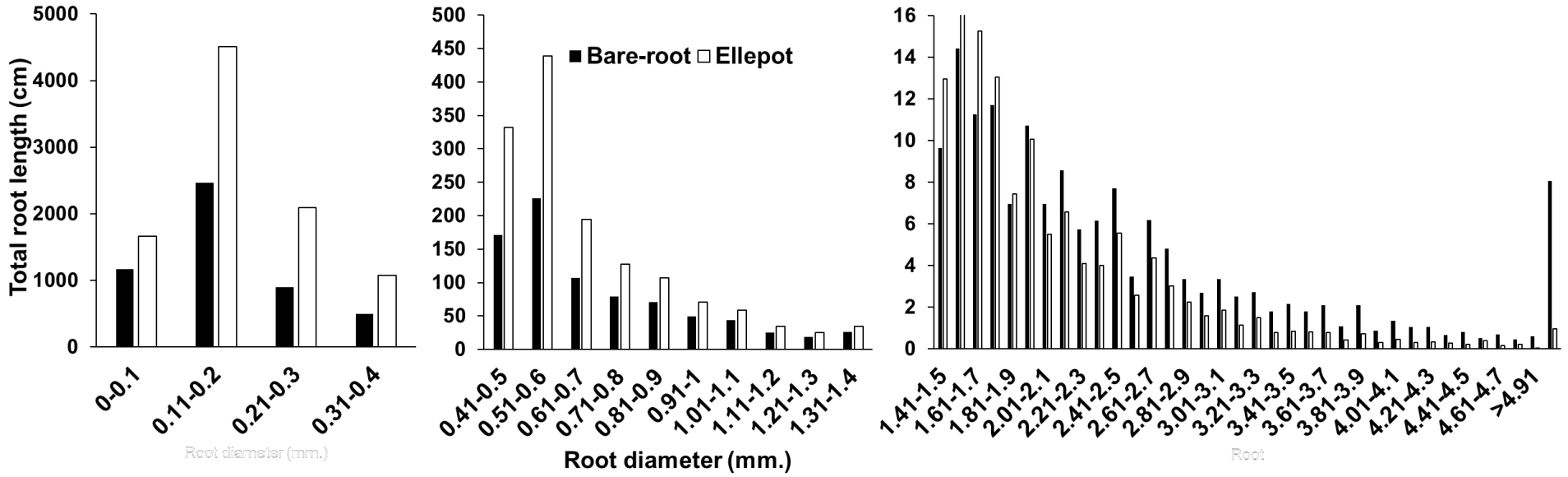




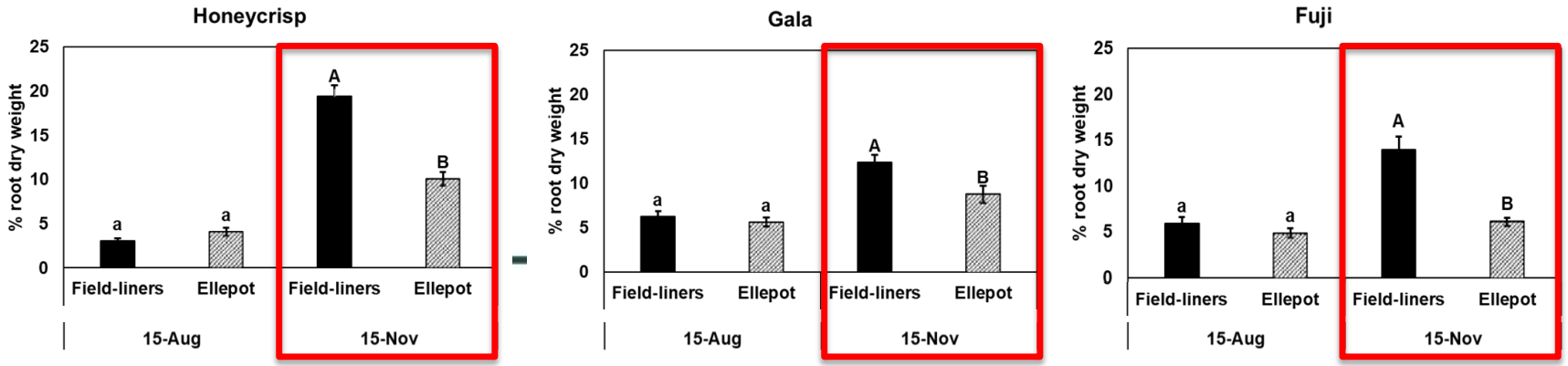


- Ellepots had 50% to 100% more ***fine-root*** production than liners
- ***Non-fine roots*** significantly greater for field-produced trees
- Fine roots account for ~95% or more of total root length

Final Root Growth Data After Nursery Year



Percent of total Plant DM Partitioned to Roots Was Reduced by Ellepot



2018 Orchard Plantings

- We established an orchard site with Ellepot and bare-root trees produced in 2017
  - In November, ~100 trees (including root systems) were excavated to evaluate root growth one year after transplanting

Table 1. Effect of Ellepot vs. Bareroot 2017 MSU nursery production of Fuji, Gala and Honeycrisp apple trees on M9 (Nic 29) rootstock on first year growth in the orchard (Clarksville Research Center). Data are means of 4 reps.

Cultivar	Nursery (location)	Production system	Total 2018 shoot growth (cm)	2018 Leader growth (cm)	Total annual growth (cm)
Fuji	MSU	Ellepot	232.7	58.4	291.10
Fuji	MSU	Bare Root	107.7	37.6	139.36
Gala	MSU	Ellepot	199.7	63.7	263.43
Gala	MSU	Bare Root	63.9	43.6	107.26
Honeycrisp	MSU	Ellepot	50.7	38.3	91.08
Honeycrisp	MSU	Bare Root	20.9	39.6	60.41

- Ellepot-produced trees had ~50% to 150% greater total annual growth than bare-root trees… depending on the scion

Root growth after 1st leaf (2018)

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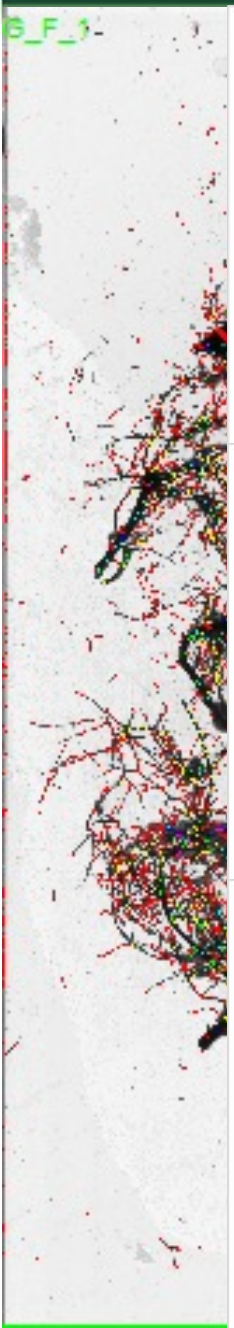

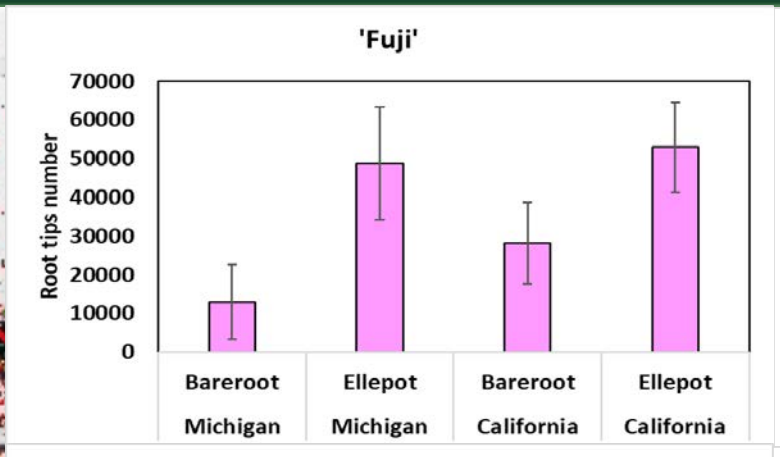

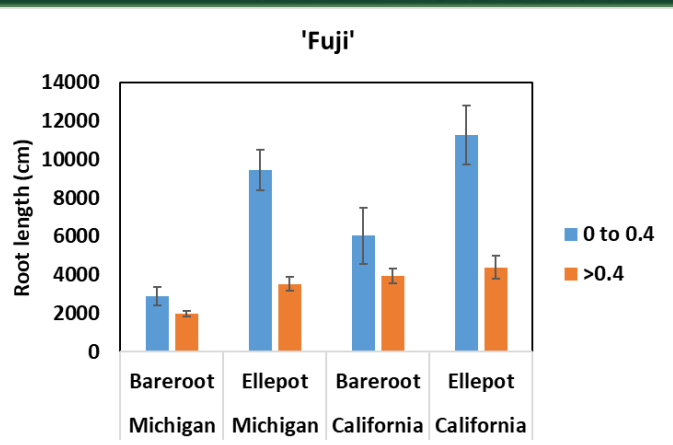

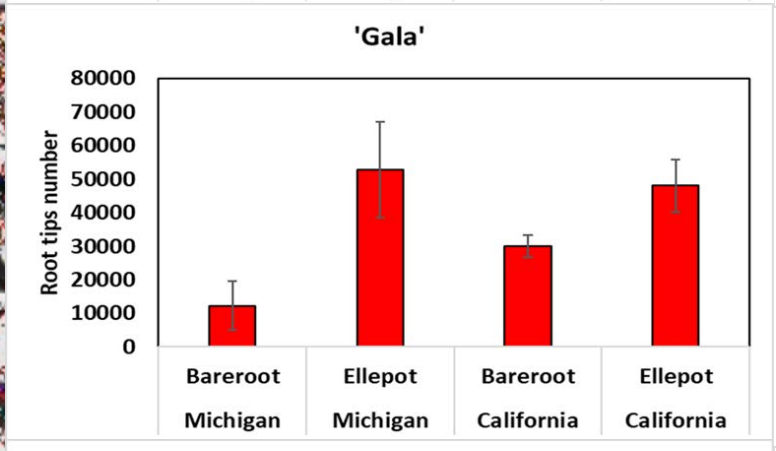

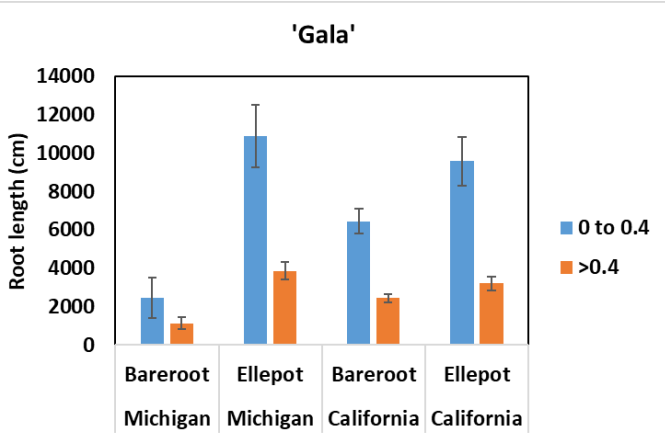

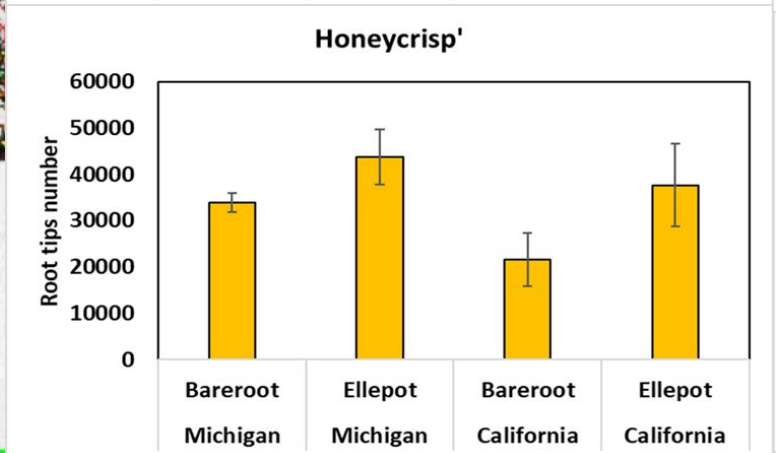

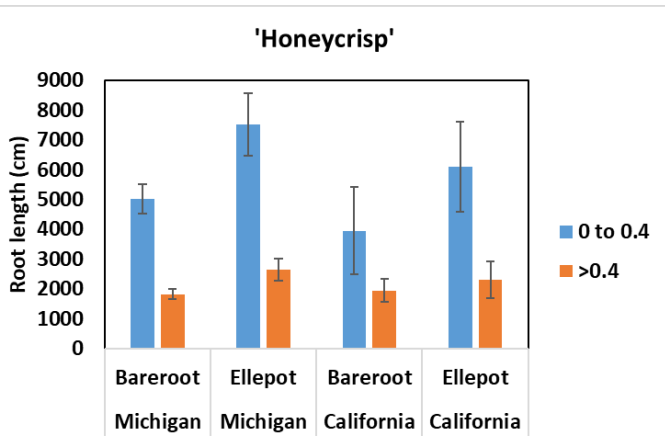

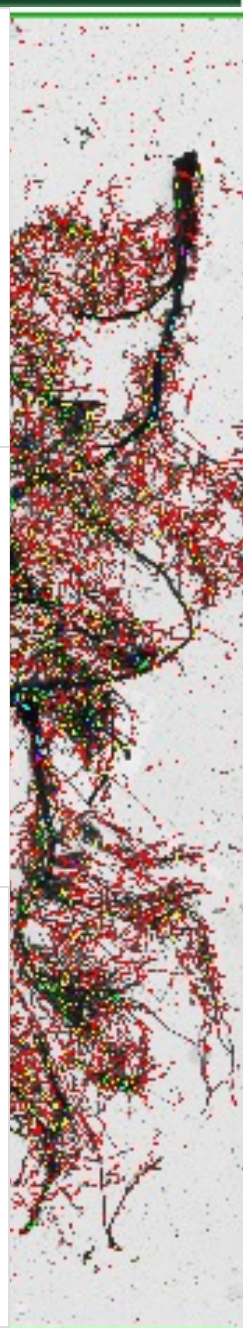

Cumulative Production

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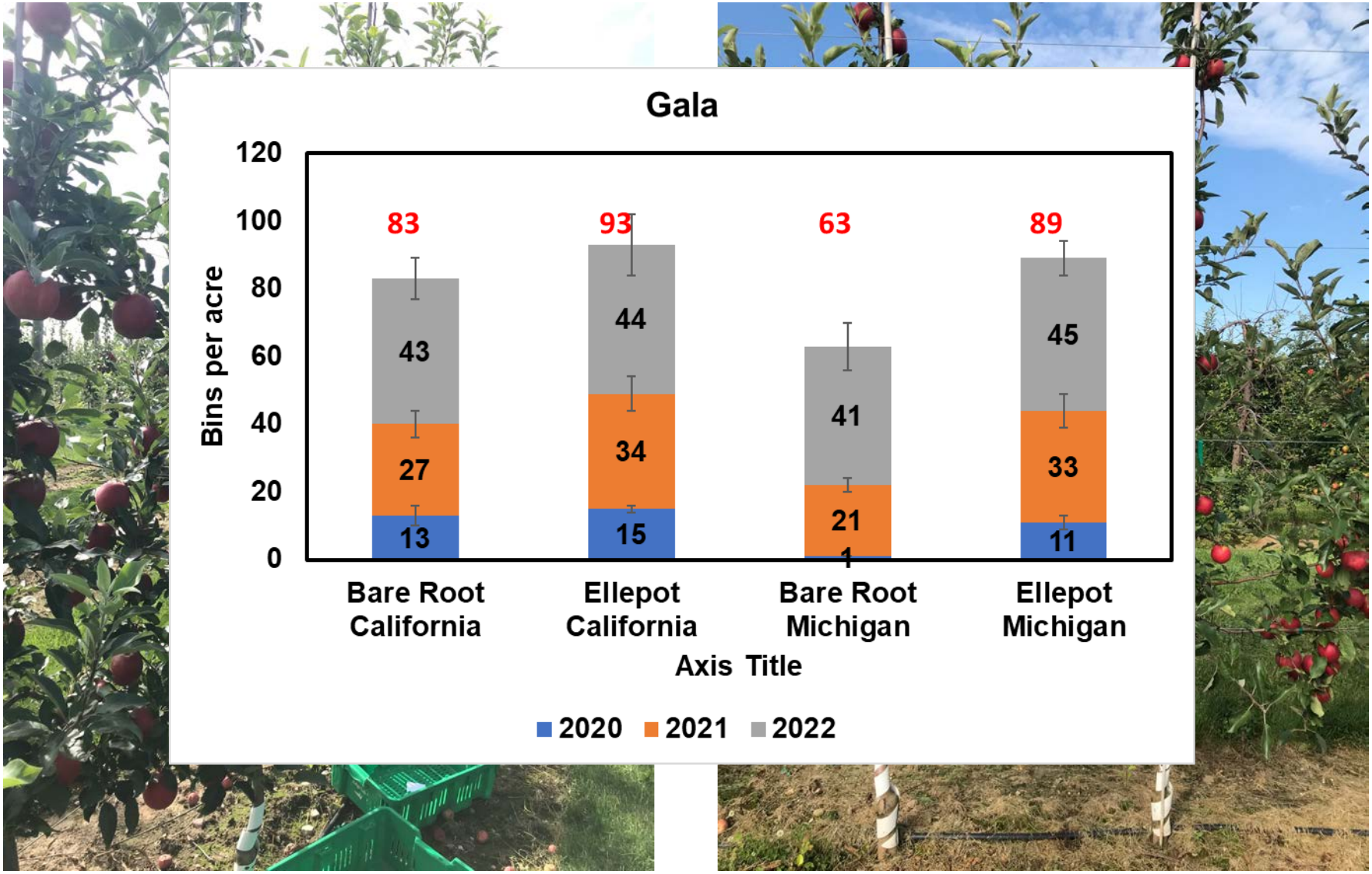

Cumulative Production

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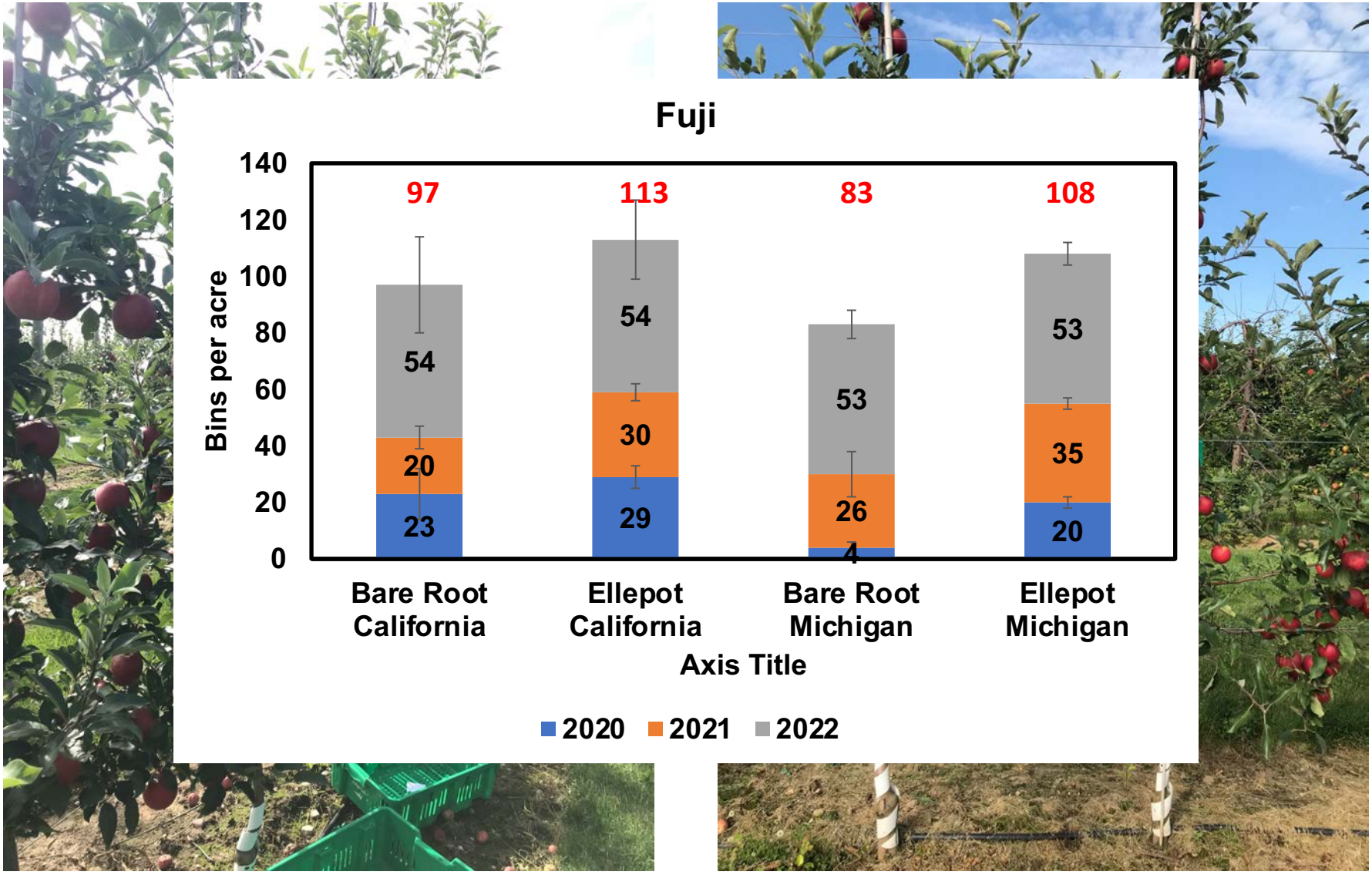

Cumulative Production

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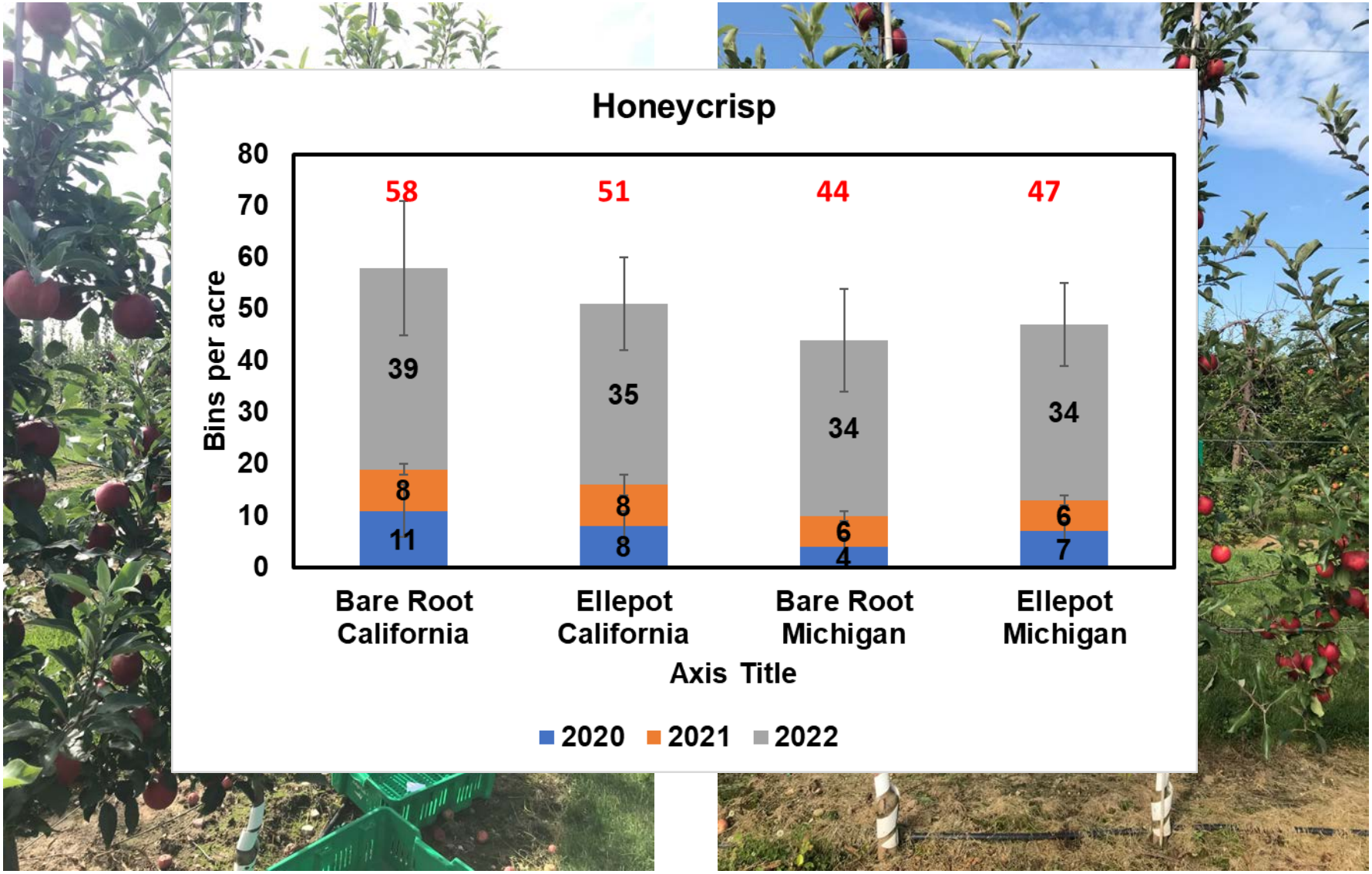

Summary

- Container produced trees offer planting flexibility and reduce transplant shock by maintaining tree balance and necessary reserves
- Container systems with air pruning stimulate production of fine roots
- These benefits led to improved canopy growth and development in the first establishment year
- Ellepot-produced trees maintained a slight advantage over field liners after 2022, but field liners have nearly ‘caught up’
- There are issues to resolve in the management of Ellepots after transplanting…

2022 Irrigation Placement

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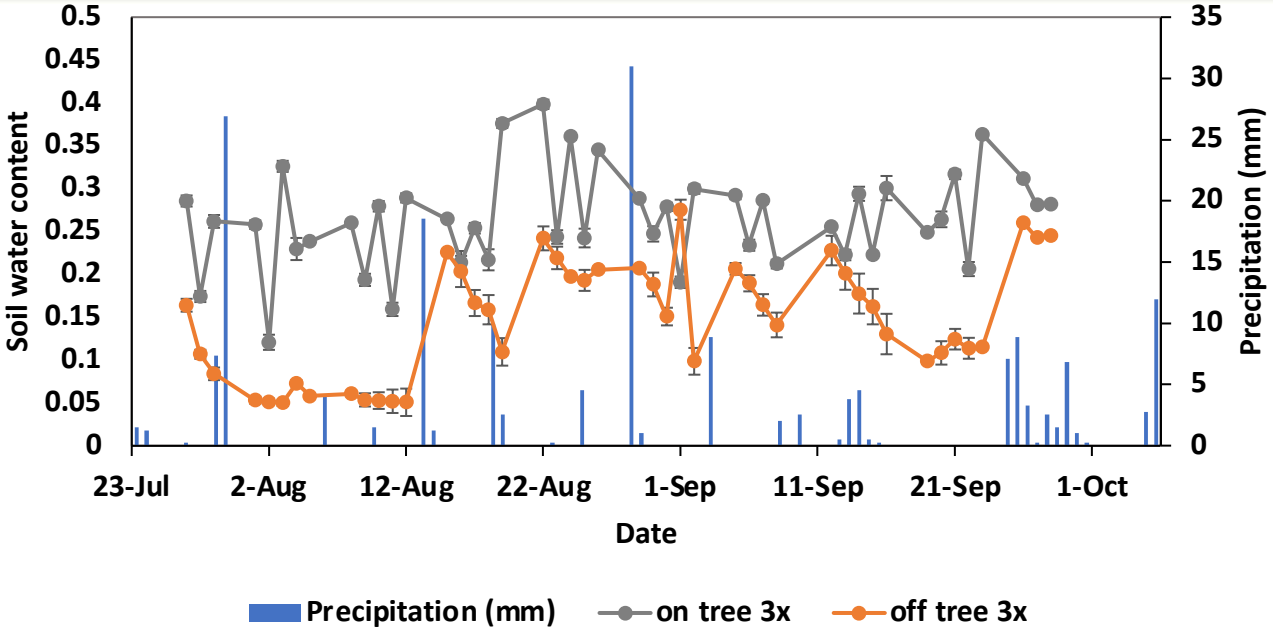

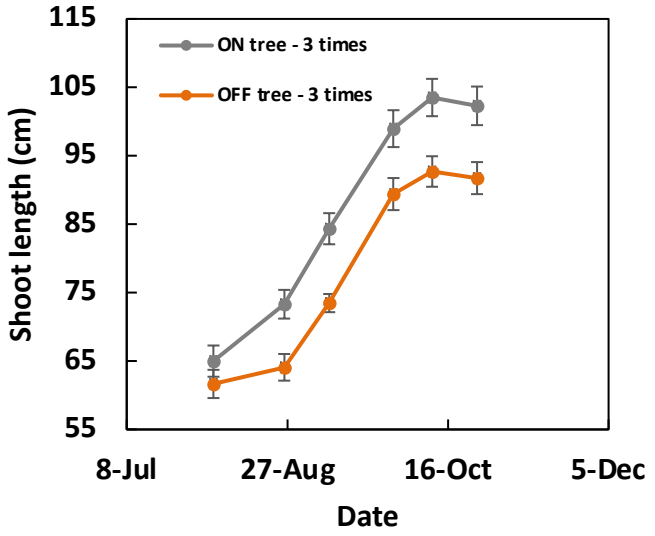

- In this experiment, trees were planted at 2 ft. apart with one emitter provided per tree, either directly over the ellepot, or between trees (i.e., 1 ft. from ellepot)
- Water placement is critical to maintaining soil moisture content within the rhizosphere and optimizing tree growth

Thank you for your attention!

- Thanks to the Michigan Apple Committee, MSU AgBioResearch (ProjectGreeen), MSU Extension, Ellepot, Skip Blackmore, Cliff Beumel and Kit Johnson for project support and/or funding
- Phil Schwallier and Nikki Rothwell, Gail ‘Peach’ Byler and Denise Ruwersma for technical support
- Mokhles Elsysy, Postdoc, and Einhorn lab team