

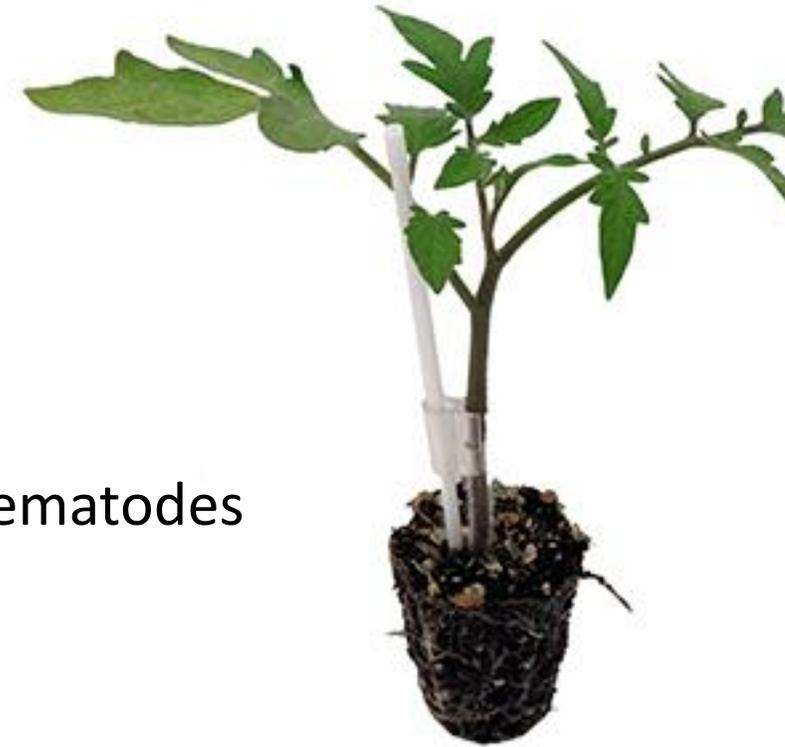
GRAFTING EXPERIENCE WITH OPEN-FIELD PRODUCTION OF HEIRLOOM TOMATOES

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UCCE Small Farms Advisor
Yolo, Solano and Sacramento Counties
Organic Pest Management Workshop
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Why Graft?

- Combine the features of two cultivars
- Scion: Fruit traits desired by consumers
- Rootstock: traits desired by the producers
 - Resistance and/or tolerance to soil-borne disease and nematodes
 - Increased abiotic stress tolerance
 - Increased vigor & fruit size
 - Fruiting over a longer period
 - Mostly interspecific hybrids between cultivated tomato (*Solanum lycopersicum*) and wild species (typically *S. habrochaites*, less commonly *S. peruvianum* or *S. cheesmaniae*)
- Source: www.mightymato.com (Plug Connection, Vista, CA)



Vine length: 30+ feet
Production: 8 to 10 months



Most tomato rootstocks have been bred for greenhouse production, where they allow longer production cycles and tolerance to variable conditions

1. Seeded 4 weeks before grafting



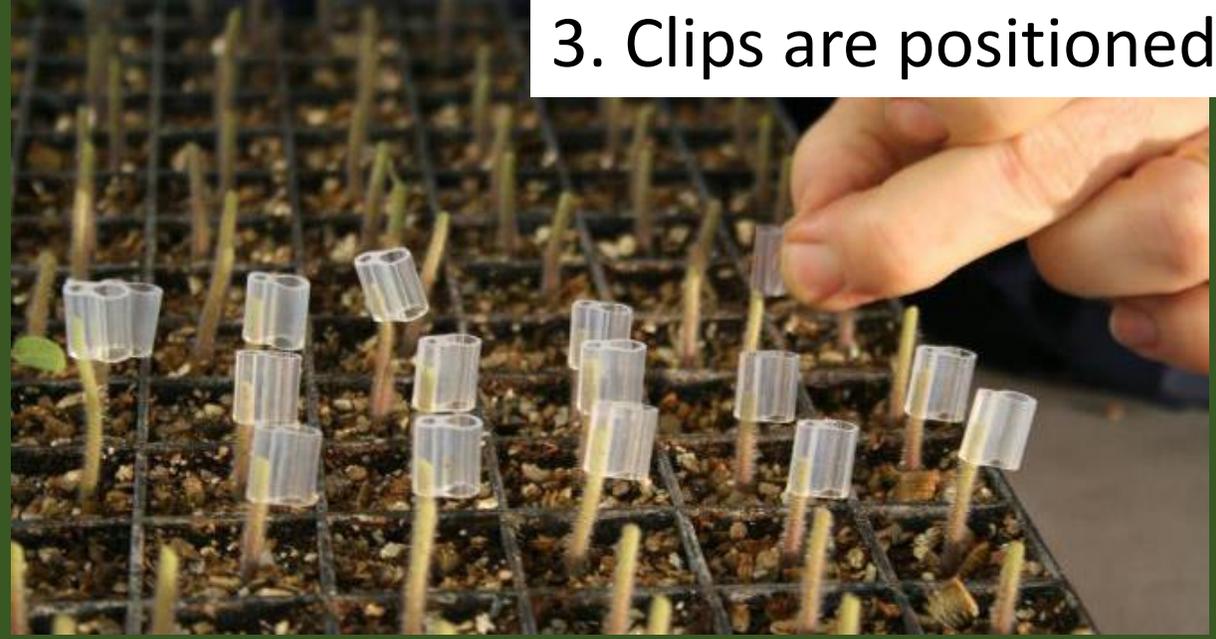
2. Splice graft: clipped at $\sim 45^\circ$ angle



4. Rootstock and scion are clipped together



3. Clips are positioned





Healing Chamber



Healing Conditions

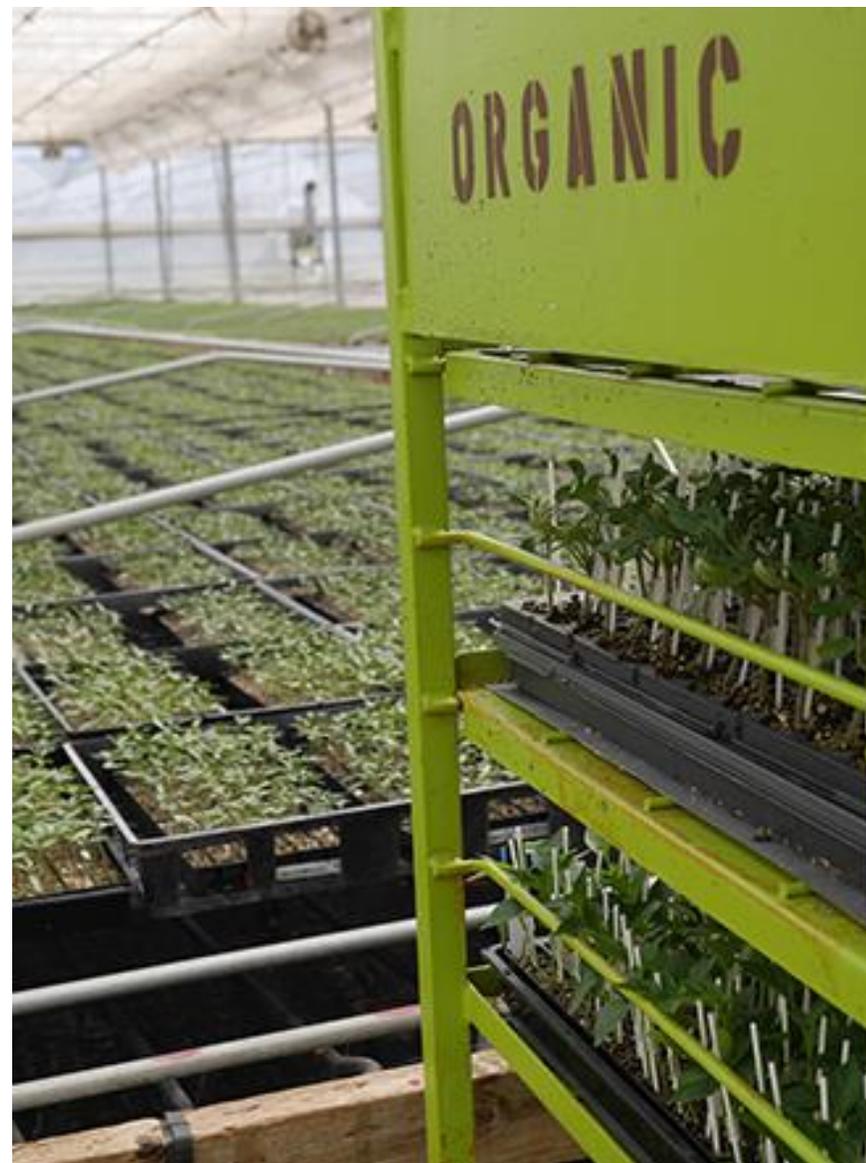
Temp: 28-29C (82-84F)

RH: 100%

Light 100 $\mu\text{mol}/\text{m}^2/\text{s}$

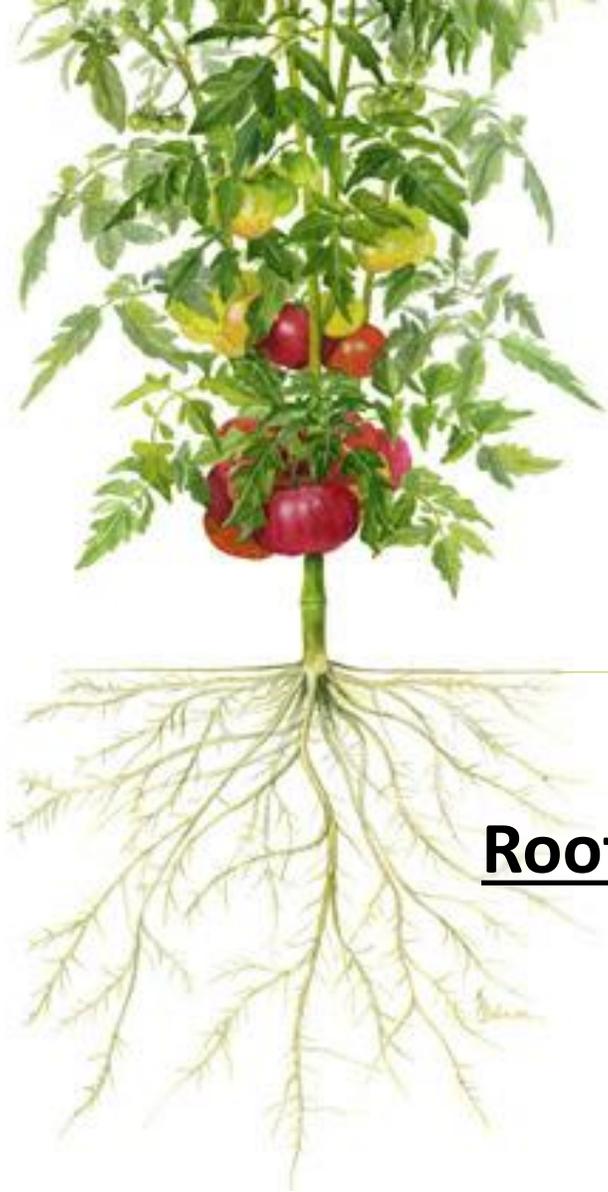
Tomatoes: 4 days

Plug Connection





Effect of rootstocks on heirloom tomatoes, UC Davis Vegetable Crops Ranch, 2017-2018



Scion

Cherokee Purple



Pink Brandywine



Rootstock

Maxifort

DeRuiter, Seminis

Multifort

DeRuiter, Seminis

DR0138TX

DeRuiter, Seminis

Estamino

Vitalis Organic Seeds, Enza Zaden

Fortamino

Vitalis Organic Seeds, Enza Zaden

Espartano

Vitalis Organic Seeds, Enza Zaden

Briomino

Vitalis Organic Seeds, Enza Zaden

E16R.40844

Vitalis Organic Seeds, Enza Zaden

Heirloom tomatoes

Targeting vigor and reduced disease impact



Fusarium wilt

Disease 'High Resistance' Table

	Tomato Mosaic Virus	Fusarium Wilt		Fusarium crown and root rot	Corky Root rot	Verticillium wilt
	Race 0-2	Race 1-2	Race 3			Race 1
<i>DRO138TX</i>	✓	✓		✓	✓	✓
<i>Multifort</i>	✓	✓	✓	✓	✓	✓
<i>Maxifort</i>	✓	✓		✓	✓	✓
<i>Estamino</i>	✓	✓		✓		✓
<i>Fortamino</i>	✓	✓		✓		✓
<i>Espartano</i>	✓	✓		✓		✓



Disease resistance

Graft union location

Field Experiment

- Randomized complete block design
- Plot size: 10' long, single bed centered on 5'
- Plant spacing: 12", single plant line
- Buried drip: 3-4"; sprinkle irrigated first 10 days
- UC Davis Vegetable Field Crops Research Site (Hutchison Road)
- Soilborne disease: Known incidence, limited knowledge, not a disease study
- Managed organically, not certified or transitional





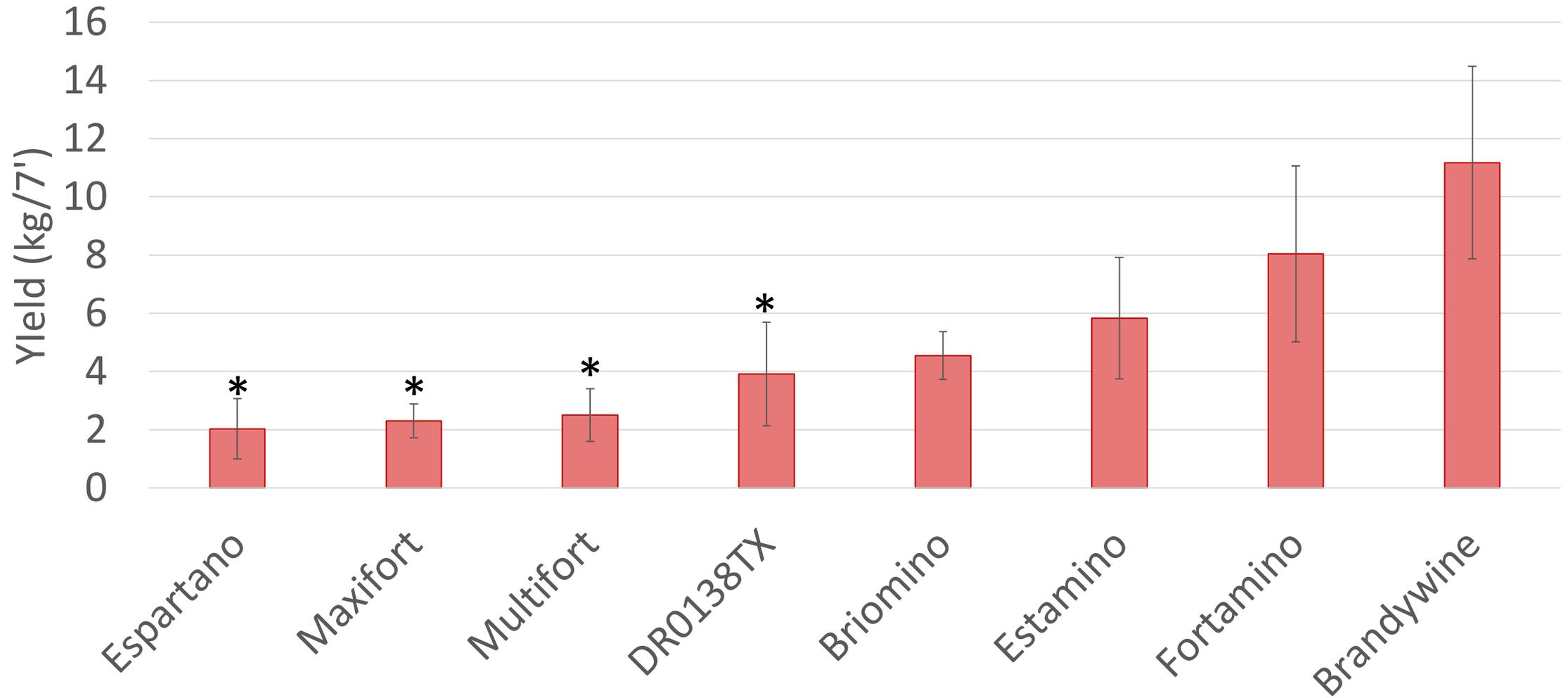
Person planting seedlings in a field.

Brandywine
Multifort
3

CPxSix



2017, Brandywine, Marketable Yield



*p < 0.05

2017 Results

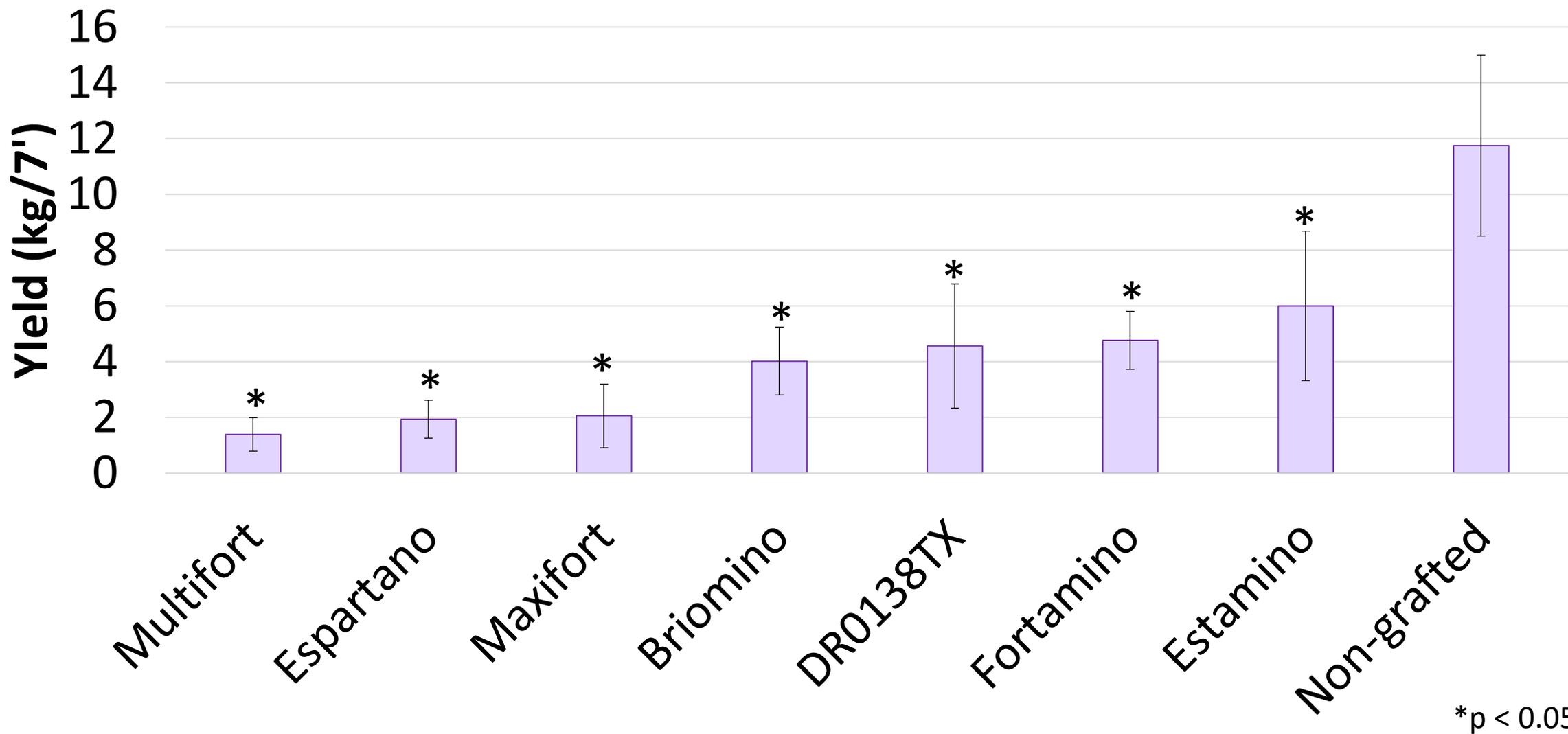


BRANDYWINE		ANOVA *p < 0.05
Non-grafted	0%	
Fortamino	-28%	
Estamino	-48%	
Briomino	-59%	
DRO138TX	-65%	*
Multifort	-78%	*
Maxifort	-79%	*
Espartano	-82%	*

ESTAMINO X
BRANDYWINE
1

MALFORT X
BRANDYWINE
2

2017, Cherokee Purple, Marketable Yield



*p < 0.05

2017 Results

CHEROKEE PURPLE		ANOVA *p < 0.05
Non-grafted	0%	
Estamino	-49%	*
Fortamino	-59%	*
DRO138TX	-61%	*
Briomino	-66%	*
Maxifort	-83%	*
Espartano	-84%	*
Multifort	-88%	*

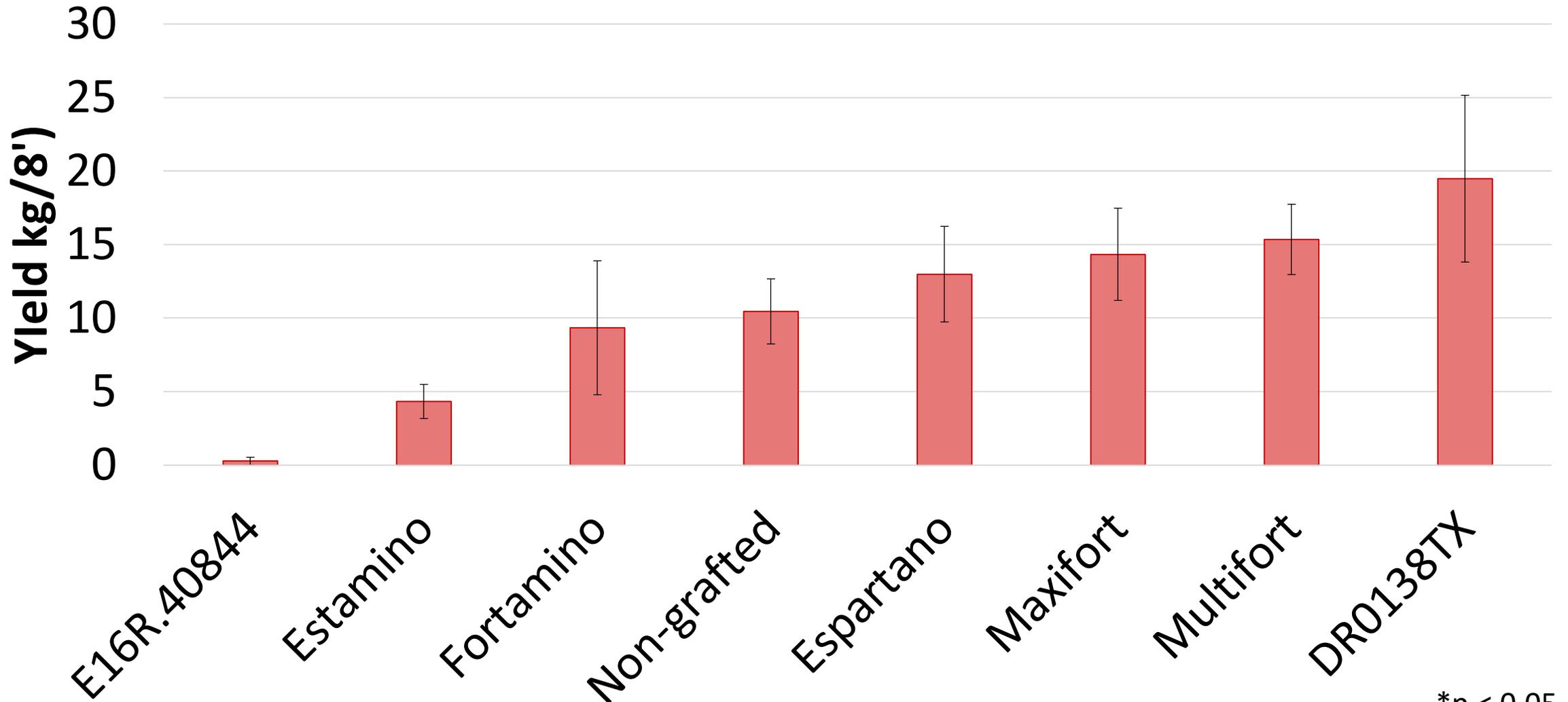


2017 Results

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2018, Brandywine, Marketable Yield



*p < 0.05

2018 Results

BRANDYWINE

ANOVA
*p < 0.05

DRO138TX

+86%

ns

Multifort

+47%

ns

Maxifort

+37%

ns

Espartano

+24%

ns

Non-grafted

0%

Fortamino

-10%

ns

Estamino

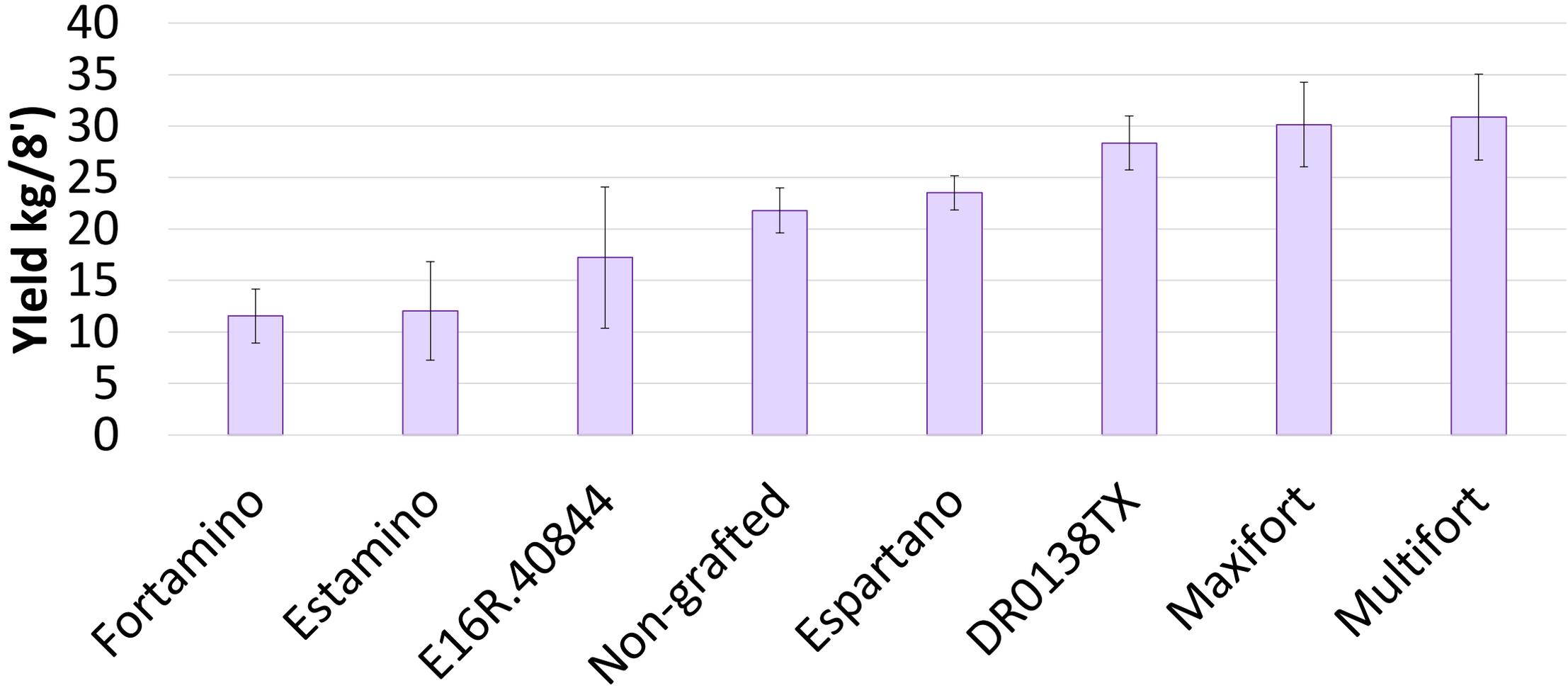
-58%

ns

ESTAMINO X
BRANDYWINE
1

MALFORT X
BRANDYWINE
2

2018, Cherokee Purple, Marketable Yield



*p < 0.05

2018 Results

CHEROKEE PURPLE

ANOVA
*p < 0.05

Multifort

+42%_{ns}

Maxifort

+38%_{ns}

DRO138TX

+30%_{ns}

Espartano

+7%_{ns}

Non-grafted

0%_{ns}

E16R.40844

-21%_{ns}

Estamino

-44%_{ns}

Fortamino

-47%_{ns}



2018 Results

CHEROKEE PURPLE

ANOVA
*p < 0.05

Multifort	+42%	<i>ns</i>
Maxifort	+38%	<i>ns</i>
DRO138TX	+30%	<i>ns</i>
Espartano	+7%	<i>ns</i>
Non-grafted	0%	
E16R.40844	-21%	<i>ns</i>
Estamino	-44%	<i>ns</i>
Fortamino	-47%	<i>ns</i>

BRANDYWIN

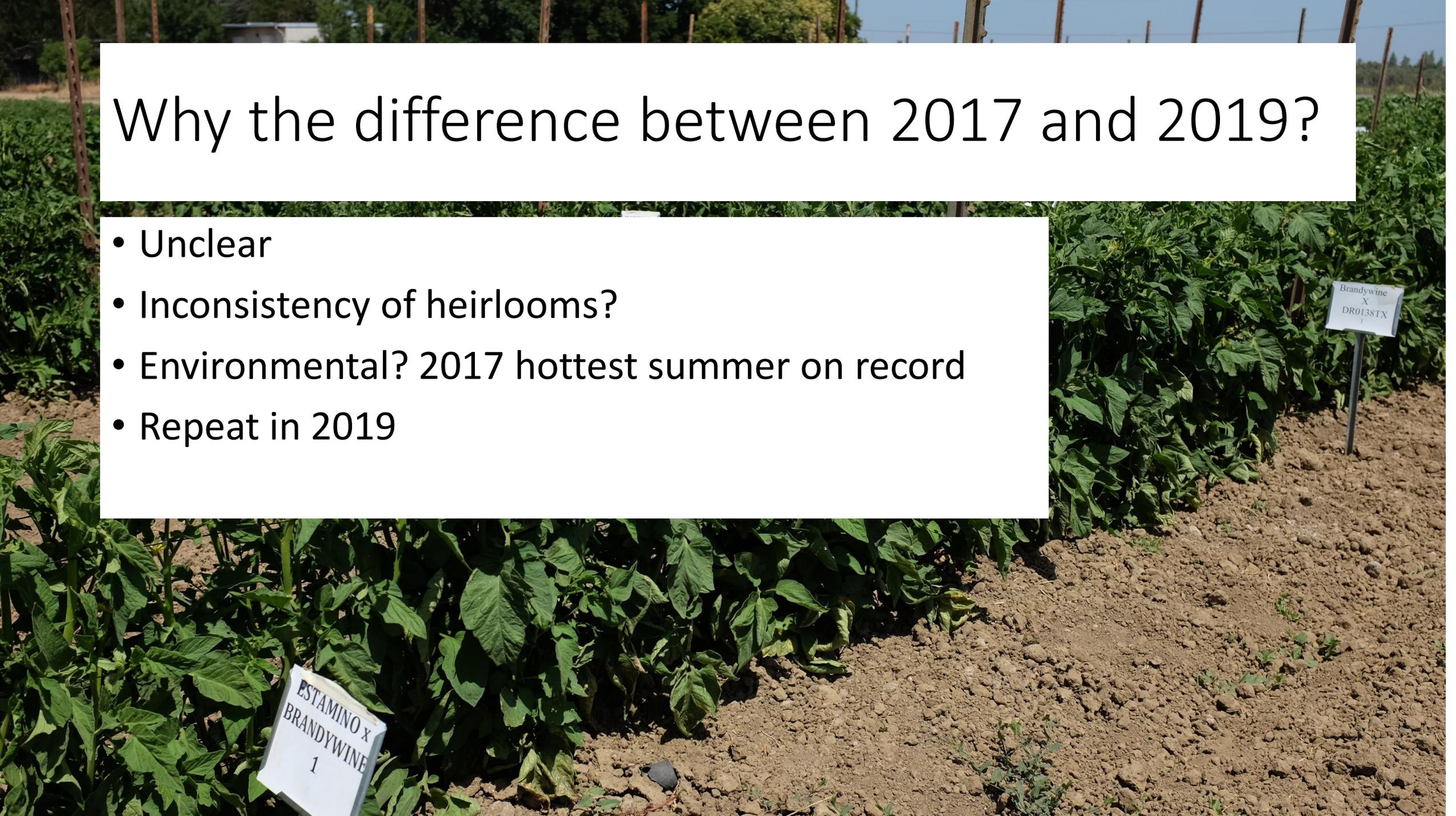
ANOVA
*p < 0.05

DRO138TX

	+86%	<i>ns</i>
Multifort	+47%	<i>ns</i>
Maxifort	+37%	<i>ns</i>
Espartano		
	+24%	<i>ns</i>
Non-grafted	0%	
Fortamino		

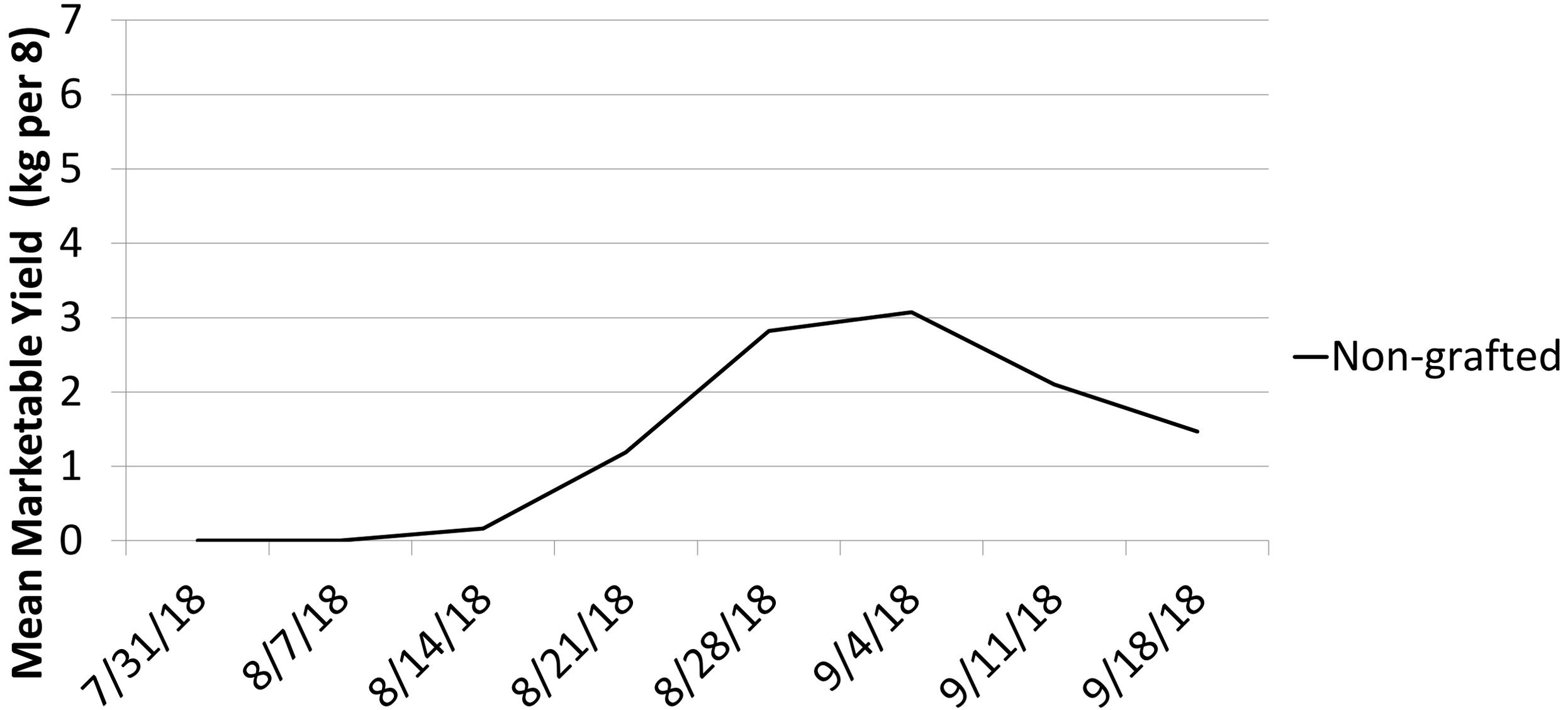
Why the difference between 2017 and 2019?

- Unclear
- Inconsistency of heirlooms?
- Environmental? 2017 hottest summer on record
- Repeat in 2019



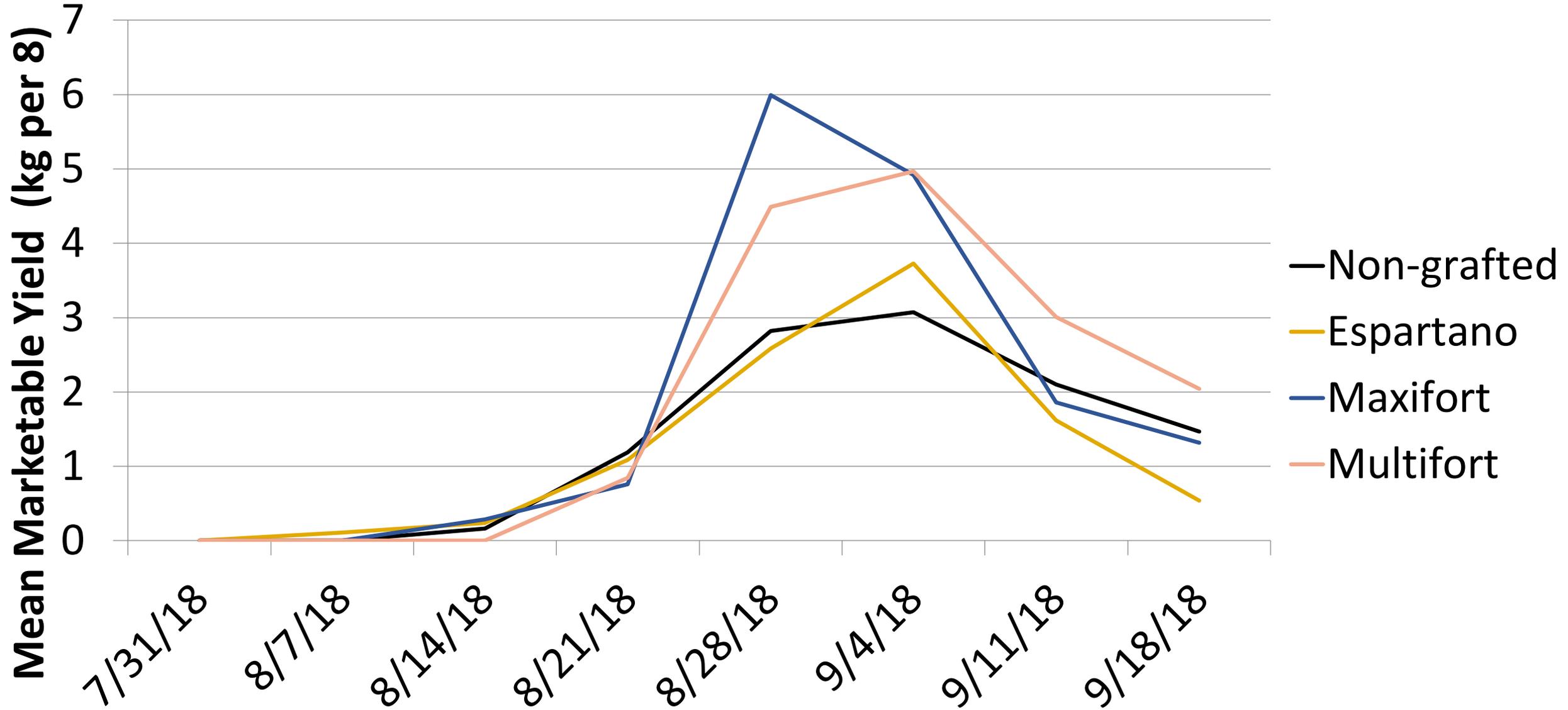
Marketable Fruit Yield Curve, 2018

BRANDYWINE



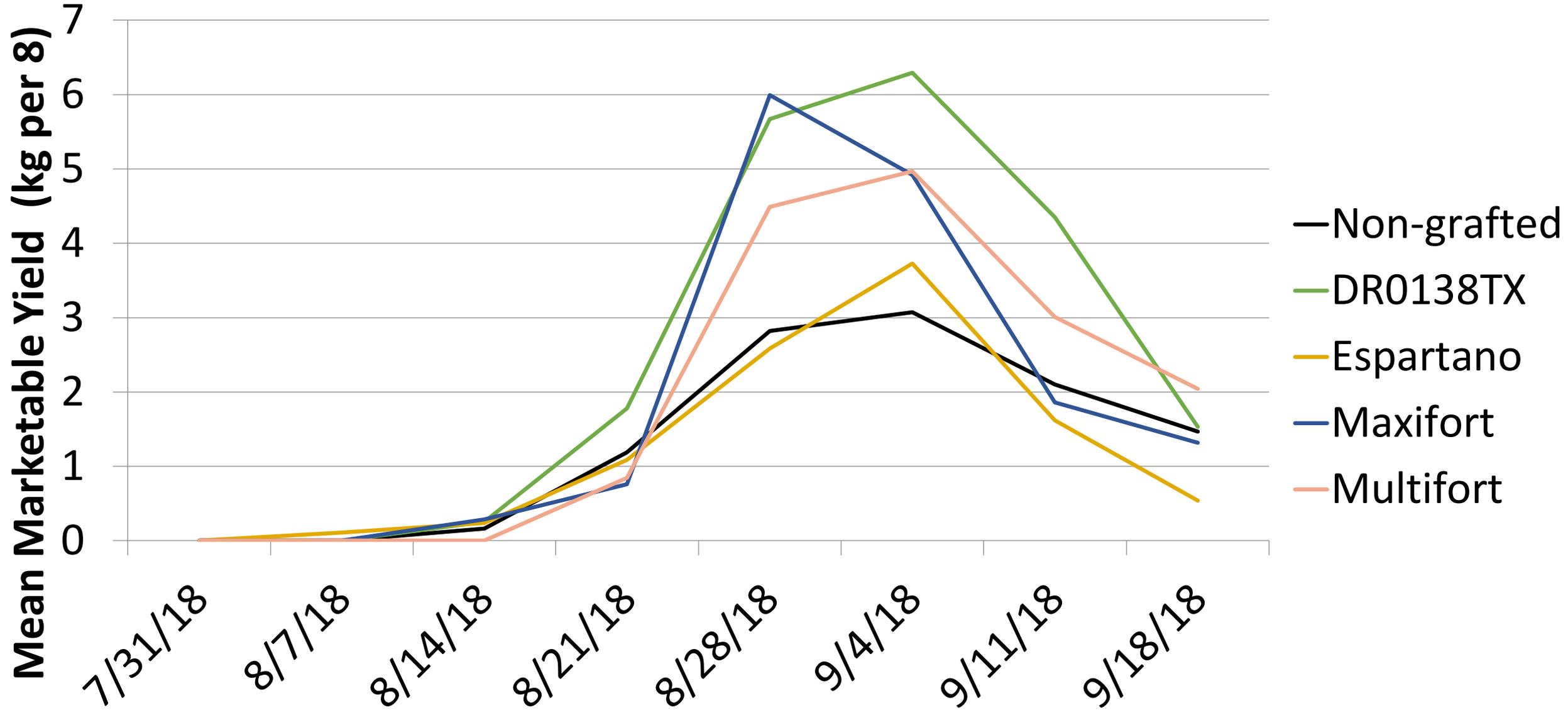
Marketable Fruit Yield Curve, 2018

BRANDYWINE



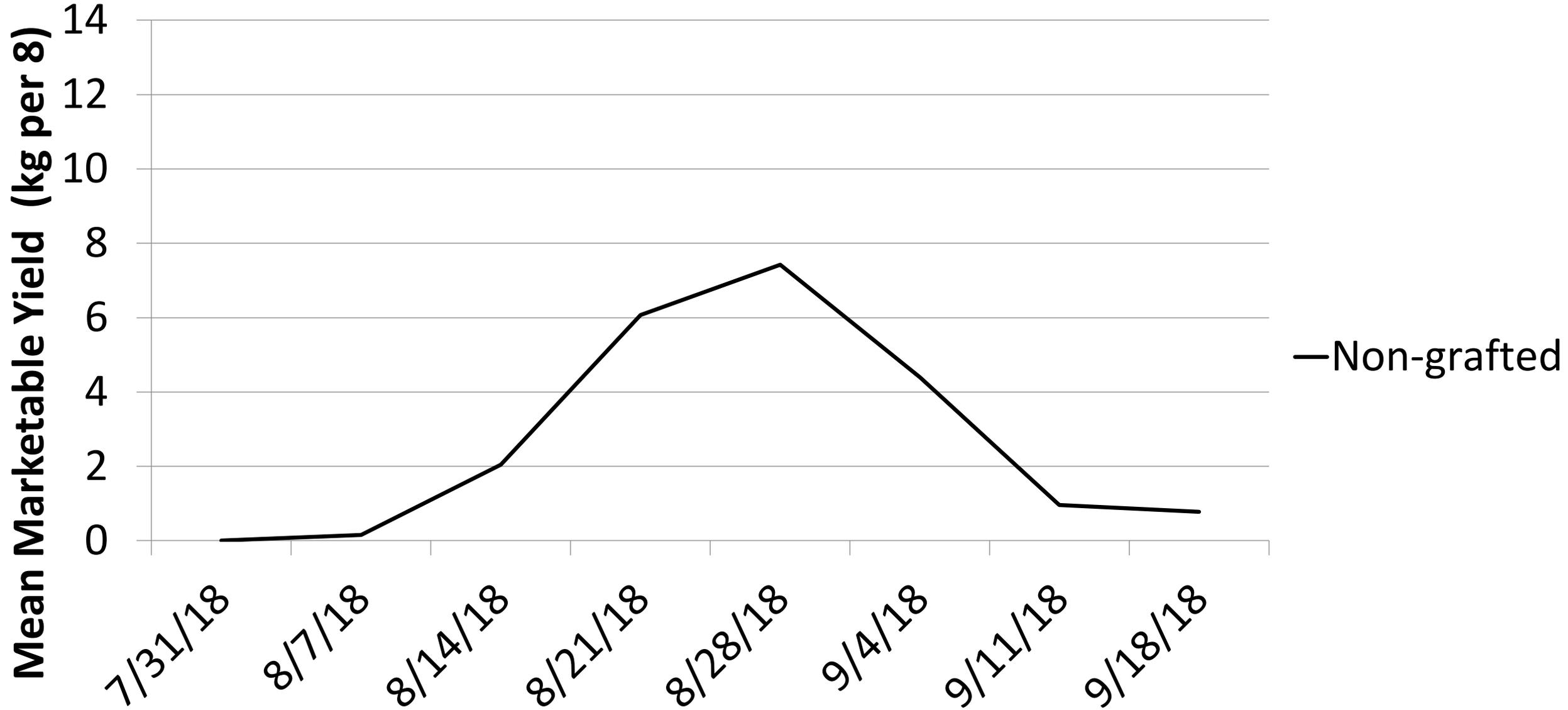
Marketable Fruit Yield Curve, 2018

BRANDYWINE



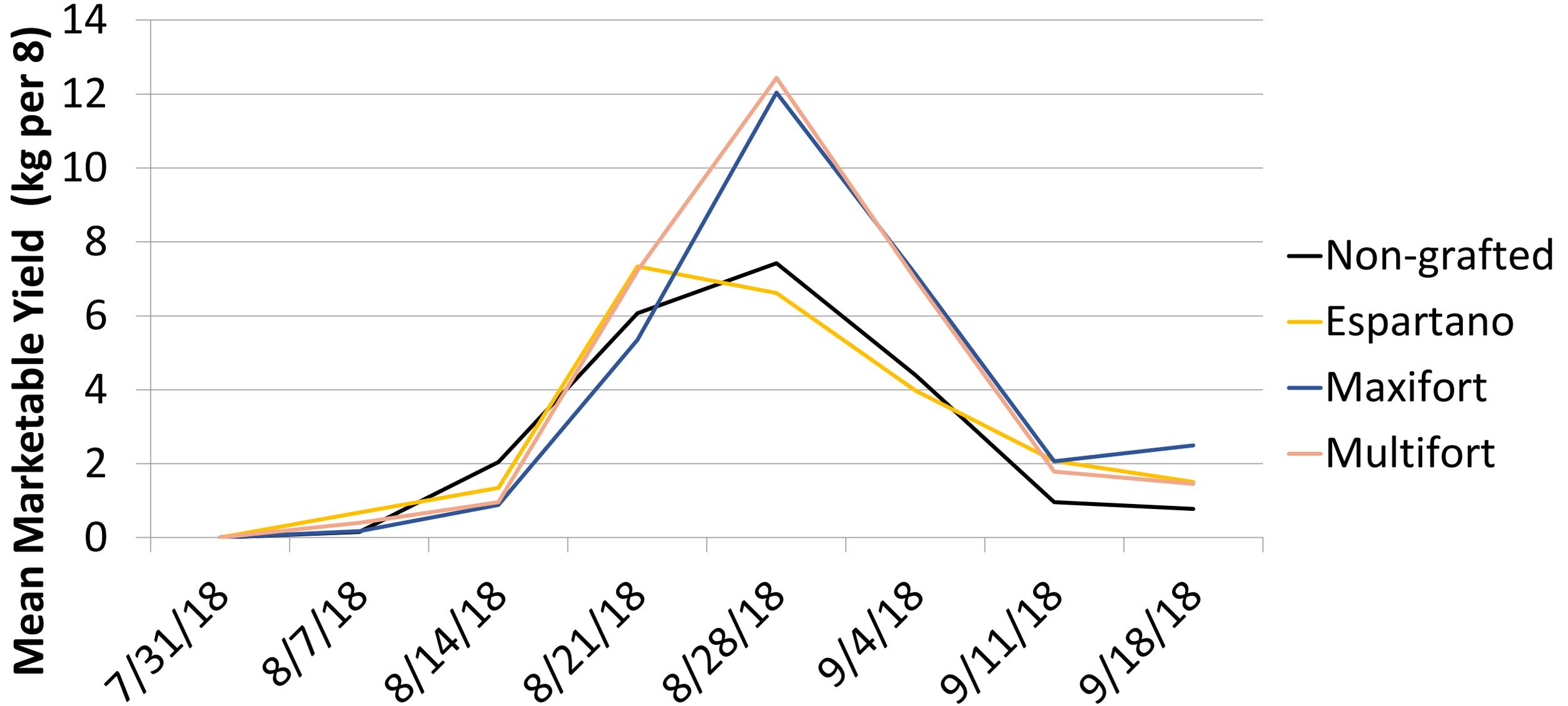
Marketable Fruit Yield Curve, 2018

CHEROKEE PURPLE



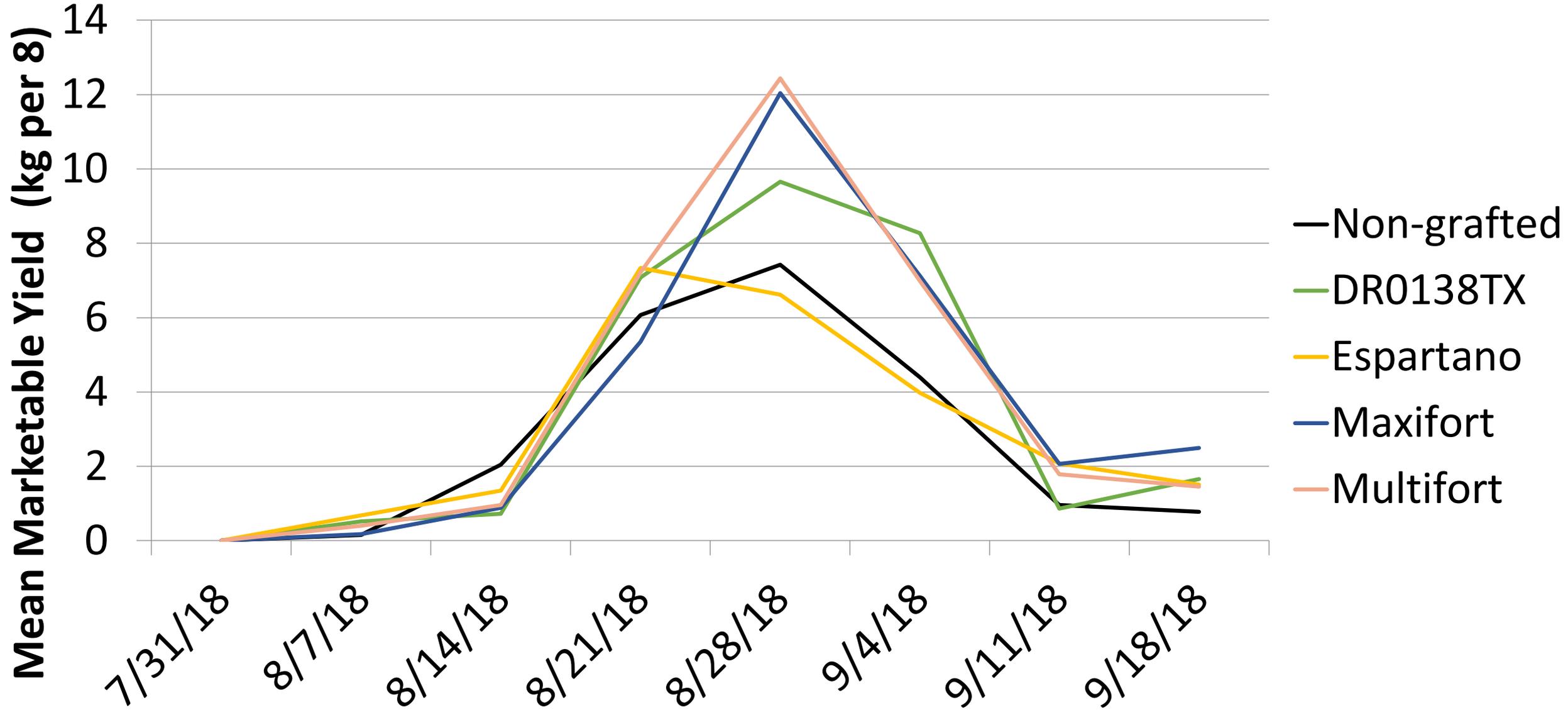
Marketable Fruit Yield Curve, 2018

CHEROKEE PURPLE



Marketable Fruit Yield Curve, 2018

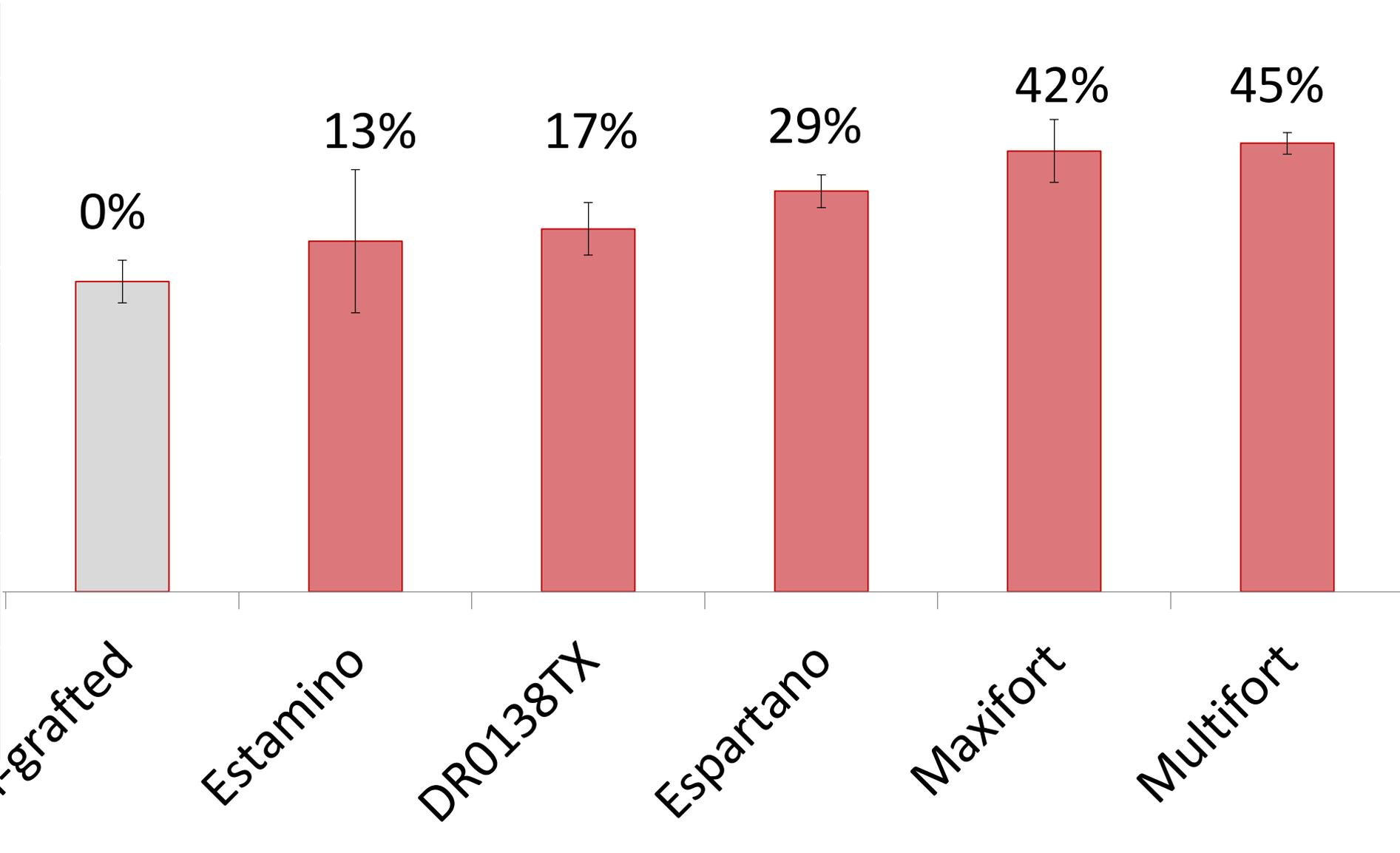
CHEROKEE PURPLE



Mean Fruit Size, 2018

BRANDYWINE

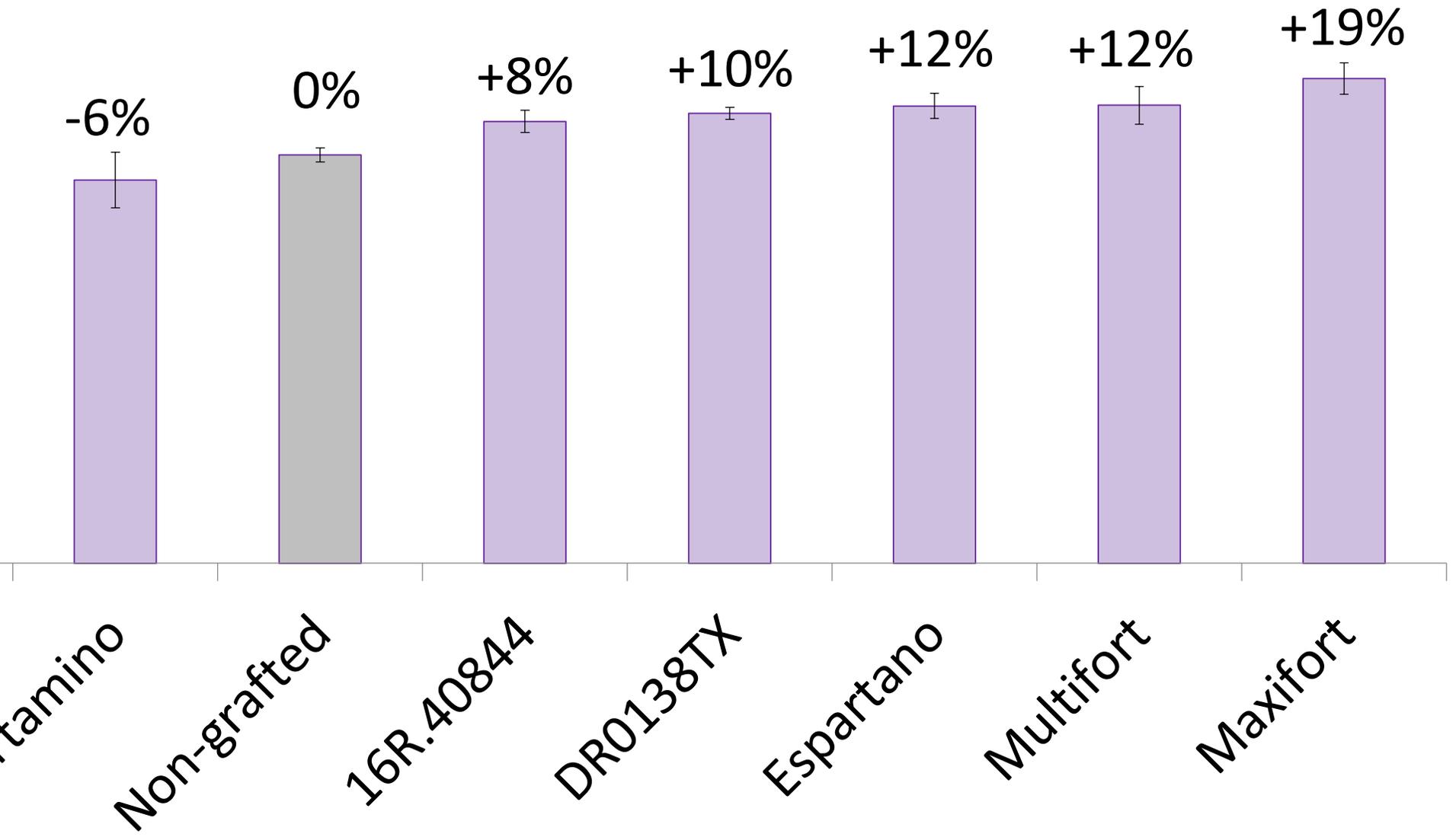
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Mean Fruit Size 2018

CHEROKEE PURPLE

CHEROKEE PURPLE	
Multifort	+42%
Maxifort	+38%
DRO138TX	+30%
Espartano	+7%
Non-grafted	0%
E16R.40844	-21%
Estamino	-44%
Fortamino	-47%



COST



- 0.80 – 1.00 (not including seed)
- \$0.25 + over sow: \$0.30-0.40 rootstock is consistent
- **\$1.10-1.40 per seedling**
- Plug Connection, Vista, CA
- 102 cell pack
- 8 week from sowing to shipping
- Certified organic

COST

Additional Costs for Grafting

Ex. 1000 plants

\$1250 Grafted Seedlings (\$1.25/plant)

- \$ 225 Non-grafted seedlings (\$40/200 tray)

\$1025 additional cost

≈ \$1 more per plant



Conclusions

- Inconsistent and unpredictable. Heirloom tomato effect?
- Growth habit is acceptable—not too large
- Shift in fruit size distribution towards large, depending on scion and rootstock.
 - DRO138TX did not increase fruit size as much as Maxifort and Multifort
 - Brandywine had significantly larger fruit on Maxifort and Multifort
 - Cherokee Purple fruits were not as impacted by rootstock
- Potential shift in fruit production timing?
 - DRO138TX widened the harvest window/peak harvest
- *Disease resistance*

Conclusions, fresh market (green) trials, San Joaquin Co.

- Higher vigor, better fruit cover at harvest, reduced sunburn
- Shift in fruit size distribution towards large and extra large
- No obvious visual problems with fruit quality
- At three lower yielding sites, increase with grafting averaged 33% over three years
- At three higher yielding sites, there was no advantage when averaged over the three years
- Yield difference averaged over all six sites was 12%



- Increase yield 10-30%
- Increase fruit size
- Alter fruit production timing, typically later
- Disease resistance
- Scion-Rootstock Interaction
- Location specific

General Conclusions

ACKNOWLEDGEMENTS

FIELD SUPPORT

- UC Davis Vegetable Crops
- Evie Smith
- Patricia Lazicki
- Jesus Martinez Rodriguez
- Jasmine P Ramirez Bonilla



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- Enza Zaden/Vitalis Seed
- Johnny's Seed
- Plug Connection

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- Gene Miyao
- Dr. Maegen Simmonds
- Dr. Tom Gordon



Thank you for your attention!

Questions?

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