

Alternative Specialty Crops in Florida: Opportunities and Challenges

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Alternative crop research at GCREC...

Artichoke



Pomegranate



Blackberries



Hops



Artichoke

ARTICHOKE
\$4.99 /EA.
PRODUCT OF USA
4084

FROST KISSED
To Delicious
Once cooked, the fibers
disappear, leaving
delicious, green Artichoke
For a wealth of Artichoke
facts, health benefits
and cooking tips,
visit [www.freshfromtheearth.com](#)

**Frost Kissed®
Artichokes**
Frost Kissed® Artichokes are
grown in California's Central Valley
under the watchful eye of our
farmers. The sweet, tender hearts
are packed with nutrients and
are a delicious, healthy addition
to your diet. For a wealth of
Artichoke facts, health benefits
and cooking tips, visit
[www.freshfromtheearth.com](#)

Artichoke vs. Florida's major crops

Crop	Grower price (\$/lb)	Production value (\$/acre)
Strawberry	2.05	42,025
Pepper, Bell	0.55	16,255
Bueberry	3.35	15,109
Tomato	0.53	13,650
Artichoke	0.88	11,853
Cabbage	0.18	6,256
Watermelon	0.16	5,555
Cucumber	0.30	5,393
Squash	0.45	5,187
Cantaloupe	0.19	5,157
Sweet Corn	0.32	4,640
Snap Beans	0.72	3,960
Potato	0.16	3,784

HEALTH BENEFITS of ARTICHOKE JUICE



Health Benefits of Artichokes

- Reduce bad cholesterol.
- Balance glucose level.
- High in anti-oxidants.
- High in fiber.
- Good for liver health.
- Improve digestion.
- Relieve hypertension.



10 Health Benefits of... Artichokes

1. Maintains a Healthy Heart
2. Reduce Bad Cholesterol
3. Prevents & Treats Cancer
4. Balance Glucose Levels
5. Relieves Hypertension
6. Good for Liver Health
7. High In Anti-Oxidants
8. Improves Digestion
9. High in Fibre
10. Diuretic

EatHealthyLiveFit.com



ANTIOXIDANT POWER HOUSE

Research shows that cooked artichokes have more antioxidants than any other vegetable.

For more information visit www.oceanmist.com

SUPERFOOD SPOTLIGHT

Artichokes



HEALTH BENEFITS

- Low in fat
- High in dietary fiber
- Excellent source of folic acid
- High in vitamin C and K
- Full of antioxidants
- Rich in B vitamins
- Rich source of minerals like copper, calcium, potassium, iron, manganese, phosphorus

A Seamless LIFE

Nutrition Facts

Serving Size 1 artichoke (56g edible portion)

Amount Per Serving

Calories 25 Calories from Fat 0

%Daily Value*

Total Fat 0g 0%

Saturated Fat 0g 0%

Trans Fat 0g 0%

Cholesterol 0mg 0%

Sodium 70mg 3%

Total Carbohydrate 6g 2%

Dietary Fiber 5g 12%

Sugars 1g

Protein 2g

Vitamin A 2% • Vitamin C 10%

Calcium 2% • Iron 2%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories: 2,000 2,500

Total Fat Less than 65g 80g

Sat Fat Less than 20g 25g

Cholesterol Less than 300mg 300mg

Sodium Less than 2,400mg 2,400mg

Total Carbohydrate 300g 375g

Dietary Fiber 25g 30g

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4

Nutrition Facts

Serving Size (120g)

Servings Per Container

Amount Per Serving

Calories 60 Calories from Fat 0

% Daily Value*

Total Fat 0g 0%

Saturated Fat 0g 0%

Cholesterol 0mg 0%

Sodium 115mg 5%

Total Carbohydrate 13g 4%

Dietary Fiber 6g 24%

Sugars 1g

Protein 4g

Vitamin A 4% • Vitamin C 20%

Calcium 6% • Iron 8%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

Calories: 2,000 2,500

Total Fat Less Than 65g 80g

Saturated Fat Less Than 20g 25g

Cholesterol Less Than 300mg 300 mg

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Total Carbohydrate 300g 375g

Dietary Fiber 25g 30g

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4

stepintomygreenworld.com

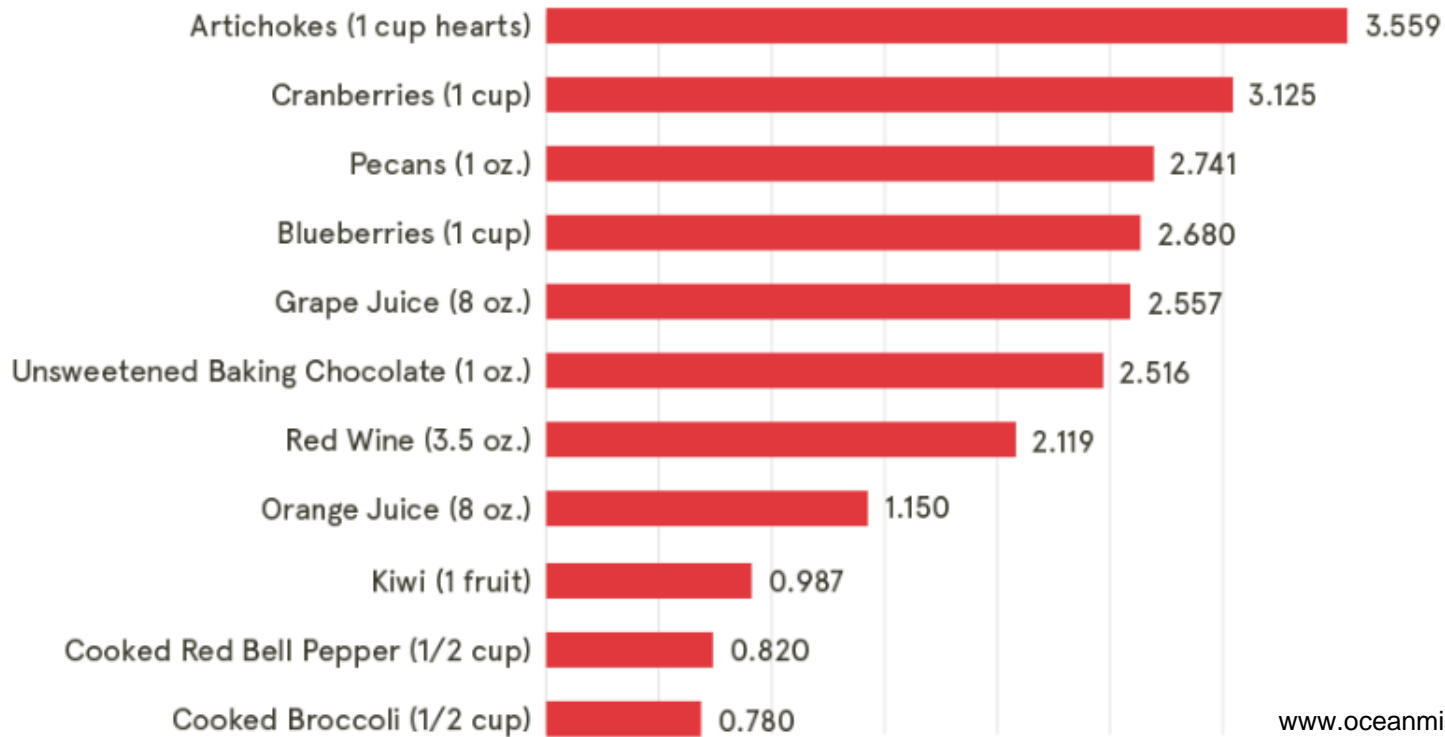
TOP HEALTH BENEFITS OF ARTICHOKE

AIDS WITH WEIGHT LOSS
BONE HEALTH
CANCER FIGHTER
CONTROL BLOOD PRESSURE
FACILITATE DIGESTION
HANGOVER TREATMENT
HEART HEALTH
HELP PREGNANCY

INCREASE BILE FLOW
LIVER HEALTH
LOWER BAD CHOLESTEROL
NATURAL DIURETIC
RICH IN ANTIOXIDANTS
TREAT ALZHEIMER'S DISEASE
TREAT DIABETES

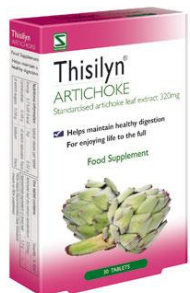
facebook.com/stepintomygreenworld pinterest.com/mygreenworld

ANTIOXIDANT CONTENT



Antioxidant Content (mmol/serving)

www.oceanmist.com



Challenges...

- **Chilling requirement**

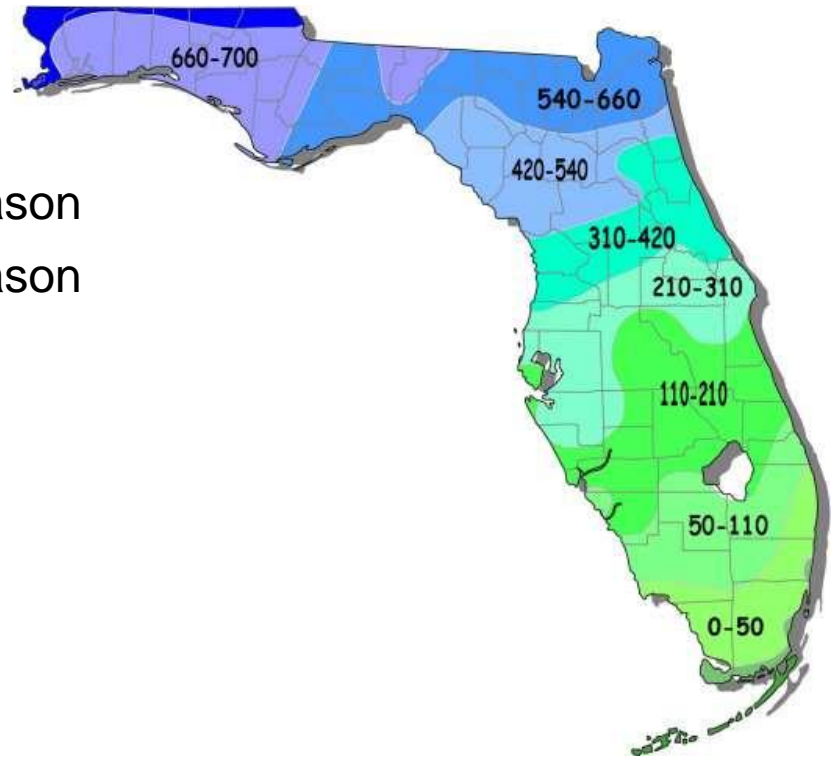
- 200 to 500 hours $<45^{\circ}$
- 103 hours in the 2015-2016 season
- 139 hours in the 2016-2017 season

- **Lack of information**

- Cultivars
- Pests and diseases
- Cultural practices

- **Market?**

- Italian restaurants in Tampa
- Farmers market



Little bud formation in Florida

Imperial Star

- Green buds
- Low chill
- Budding 0-38%

Opal

- Red buds
- Moderate chill
- Budding 0-10%

Green Globe Imp.

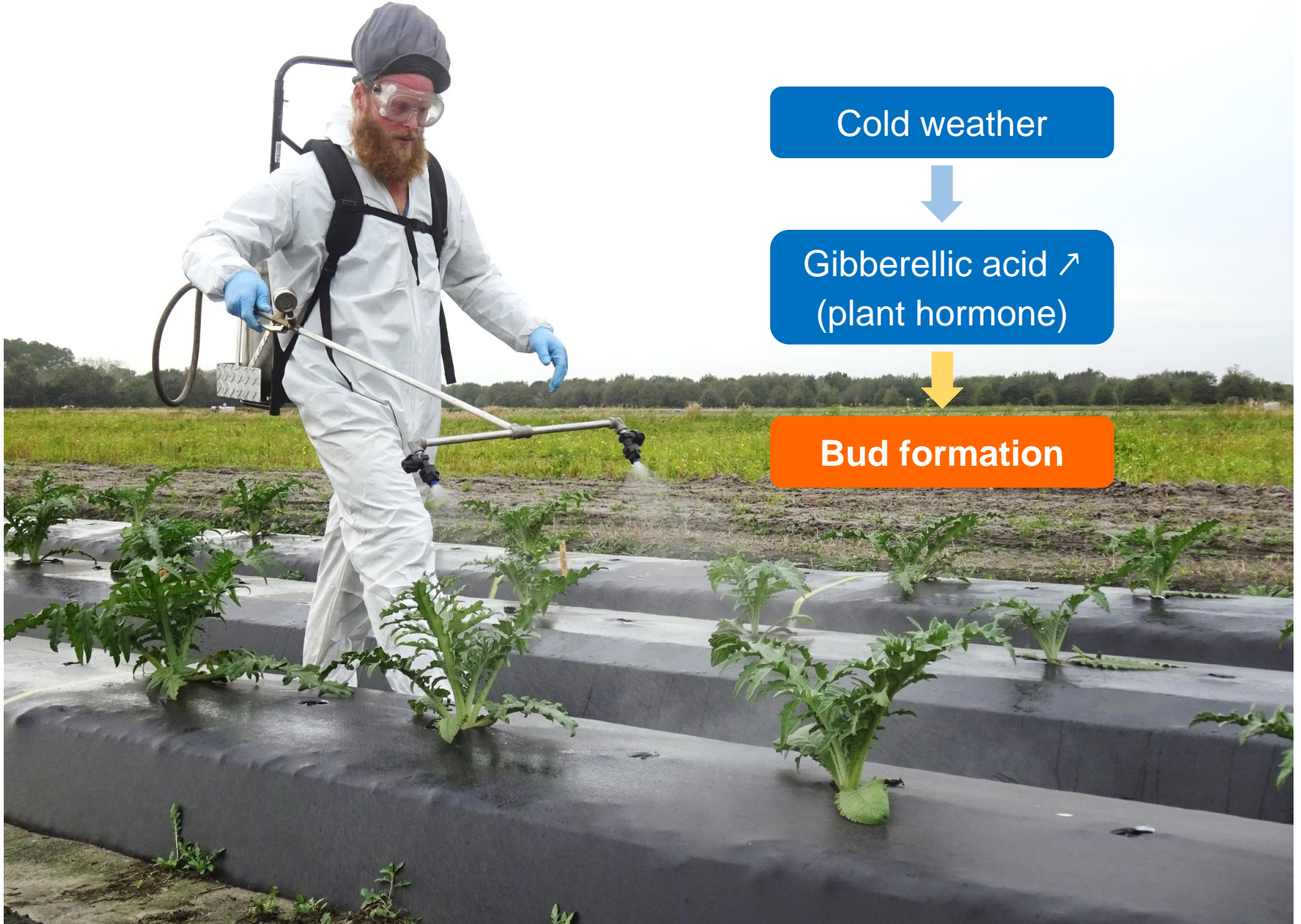
- Green buds
- High chill
- Budding 0%

Madrigal

- Green buds
- Extremely high chill
- Budding 0%



Artificial induction of bud formation by GA



Cold weather



Gibberellic acid ↑
(plant hormone)



Bud formation



Induction of bud formation by GA

2015-2016 season data

Cultivar	GA ₃ (mg/L)	Bud formation (% of plants)
GGI	0	0.0 c
	20	25.0 b
IS	0	37.5 b
	20	62.5 a

Tukey-Kramer test at $P < 0.05$.

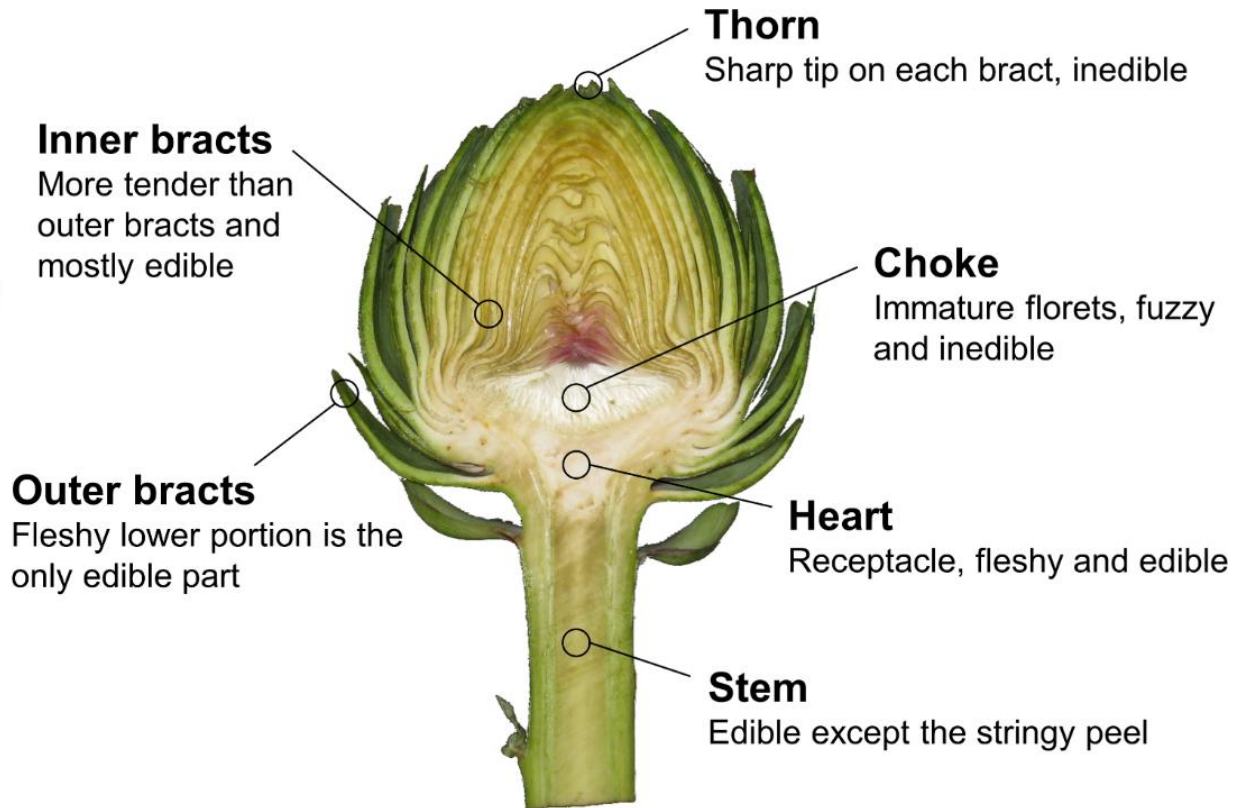
Marketable yield...

2015-2016 season data

Cultivar	GA ₃ (mg/L)	Bud number (no./plant)	Marketable yield (t/ha)
GGI	0	0.00 c	0.00 c
	20	0.22 bc	0.48 bc
IS	0	0.50 b	0.71 b
	20	1.75 a	2.91 a

Tukey-Kramer test at $P < 0.05$.











Cultivar evaluation with GA

Imperial Star

- Green buds
- Low chill
- Budding 100% with GA

Opal

- Red buds
- Moderate chill
- Budding 100% with GA

Green Globe Imp.

- Green buds
- High chill
- Budding 60-90% with GA

Madrigal

- Green buds
- Extremely high chill
- Budding 0% with GA



**This season's yield will be > 6,000 lb/A
(California = 13,000 lb/A)**



Nitrogen application rate (lb/acre/d)

0.2

0.6

1

1.5

2

30"



36"



42"



Plant spacing

Artichoke production guidelines

	Month												
	9	10	11	12	1	2	3	4	5	6	7	8	
Planting		■	■										
Vegetative growth	■	■	■	■									
Bud formation					■	■	■	■					
Harvest						■	■	■	■				

- Plant as early as mid-Sep to maximize yield in Jan-Feb (highest market prices).
- GA spray is necessary – 10 fl oz of ProGibb at Wk 6, 8, and 10.
- Standard tomato beds can be used – 5-6 ft row spacing.
- Optimal plant spacing is 3 ft.
- 300 lbs of N/acre is recommended.



Blackberry



Opportunities...

- **High nutritional values and antioxidants**
- **Increasing consumption**
- **High grower prices**
 - \$0.56/lb in 2009 → \$1.11/lb in 2014 (US)
 - Up to \$4/lb (Florida)
- **Keep labor force**
 - A lot of interests by strawberry and blueberry growers

Blackberry vs. Florida's major crops

Crop	Grower price (\$/lb)	Production value (\$/acre)
Strawberry	2.05	42,025
Pepper, Bell	0.55	16,255
Bueberry	3.35	15,109
Tomato	0.53	13,650
Blackberry (US)	1.11	8,203
Cabbage	0.18	6,256
Watermelon	0.16	5,555
Cucumber	0.30	5,393
Squash	0.45	5,187
Cantaloupe	0.19	5,157
Sweet Corn	0.32	4,640
Snap Beans	0.72	3,960
Potato	0.16	3,784

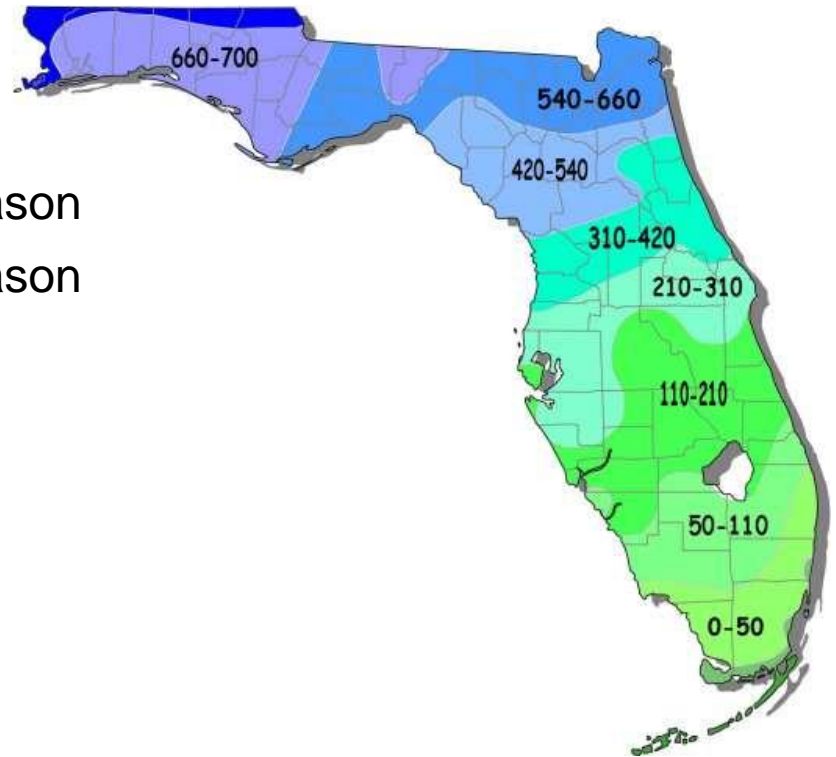
Challenges...

- **Chilling requirement**

- 300 to 900 hours $<45^{\circ}$
- 103 hours in the 2015-2016 season
- 139 hours in the 2016-2017 season

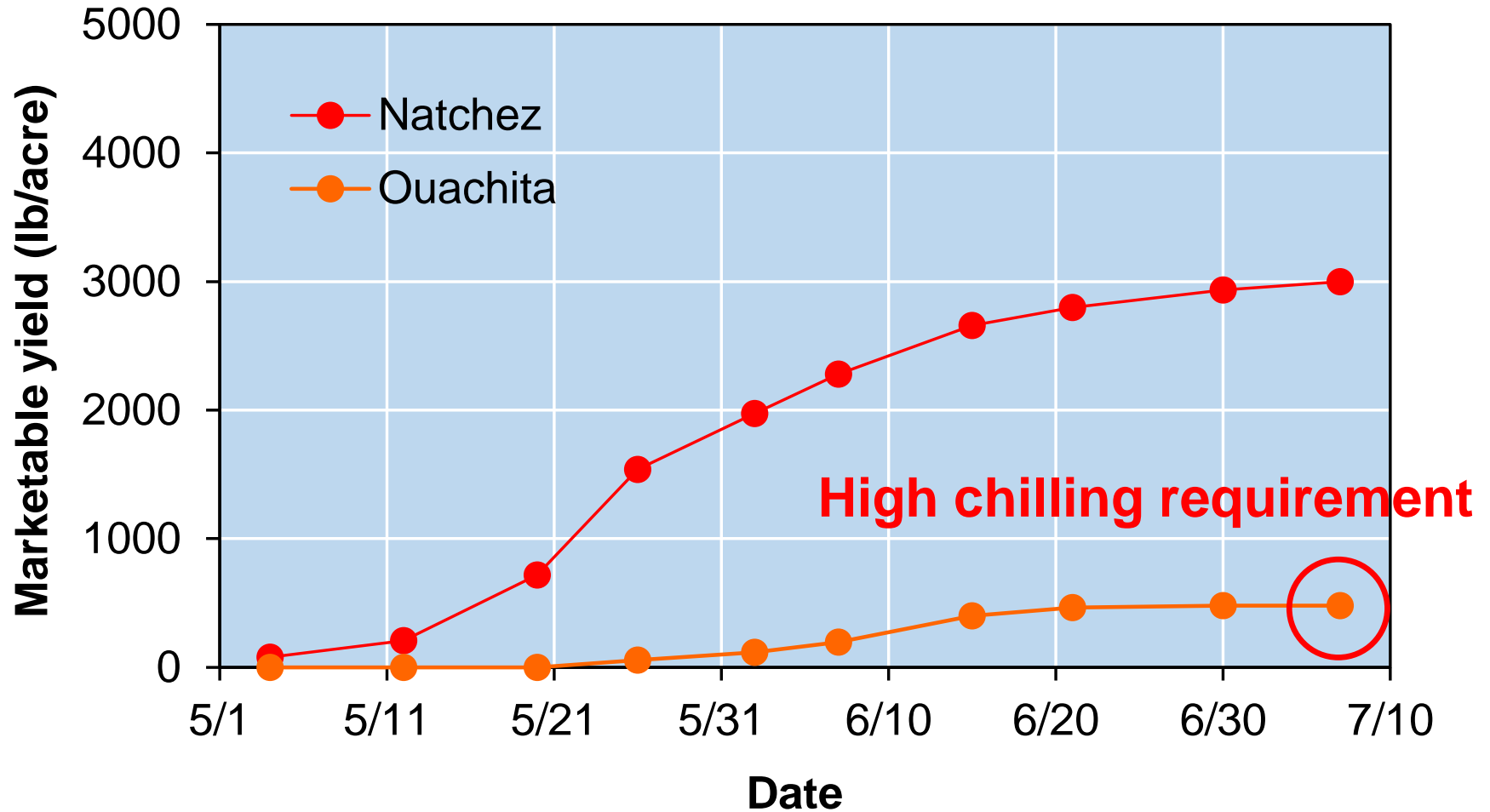
- **Lack of information**

- Cultivars
- Pests and diseases
- Cultural practices
- Pruning





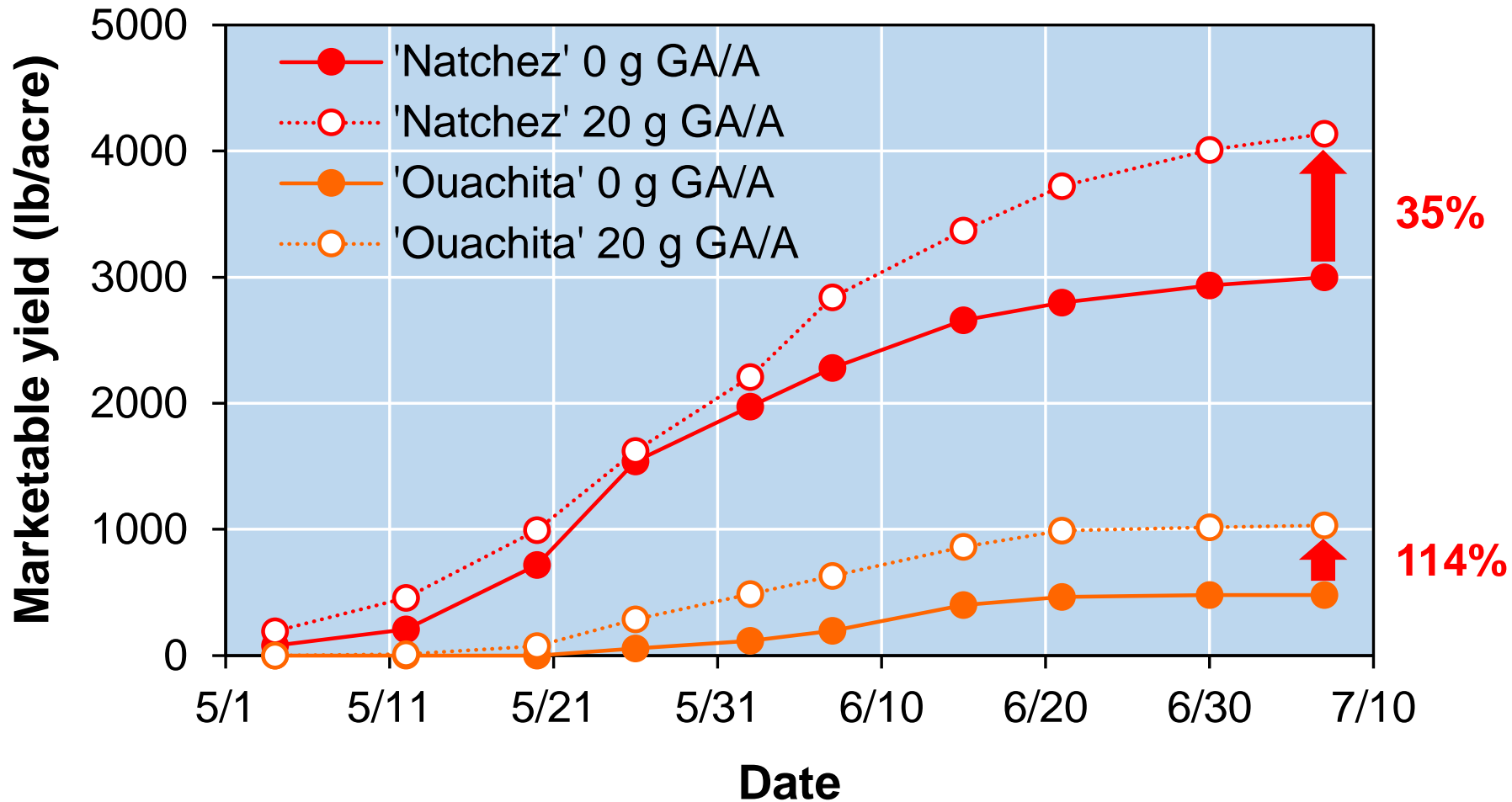
Limited yield by insufficient chill hours



Artificial bud break induction by GA



35-114% yield increases by GA



Blackberry production guidelines

	Month											
	7	8	9	10	11	12	1	2	3	4	5	6
Primocane growth	Green	Green	Green	Green	Green	Green	Grey	Grey	Grey	Grey	Grey	Grey
Dormancy	Grey	Grey	Grey	Grey	Grey	Grey	Purple	Purple	Grey	Grey	Grey	Grey
Flowering/floricane growth	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Orange	Orange	Orange	Grey	Grey
Harvest	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Orange	Orange

- Highest yielding floricane-fruiting cultivar is 'Natchez'.
- High fruit quality floricane-fruiting cultivars are 'Ouachita' and 'Osage'.
- GA spray can improve bud break – but no commercial product is currently available.
- Cane management is important: more canes → fruit set ↗ berry size ↘.
- Artificial defoliation in late Dec may be beneficial.
- Primocane-fruiting cultivars need to be evaluated.



Pomegranate

Opportunities...

- **Increasing popularity among consumers**
 - 599 farms and 24,517 acres in 2007
 - 1,056 farms and 32,887 acres in 2012
- **High health benefits**
 - High antioxidant contents
 - Fiber, potassium, vitamin C & K, folate, etc.
- **Multiple uses**
 - Fresh fruit, juice, extracts, etc.
- **Alternative crop for Florida citrus growers?**
 - Similar production practices for citrus and pomegranate

Nutrition Facts			
Serving Size 1/2 medium (154 g)			
Servings Per Container			
Amount Per Serving			
Calories 130	Calories from Fat 15		
<hr/>			
			% Daily Value*
Total Fat 2g			3%
Saturated Fat 0g			0%
Trans Fat 0g			
Cholesterol 0mg			0%
Sodium 0mg			0%
Total Carbohydrate 29g			10%
Dietary Fiber 6g			24%
Sugars 21g			
Protein 3g			
<hr/>			
Vitamin A 0%		Vitamin C 25%	
Calcium 2%		Iron 2%	
<small>*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:</small>			
	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g
<small>Calories per gram: Fat 9 • Carbohydrate 4 • Protein 4</small>			

Challenges...

- **Disease management**

- Leaf spot, fruit rot, and more...
- Fruit development during hot and humid summer
- Limited fungicide options

- **Poor fruit quality**

- Sunburn, fruit cracking, etc.

- **Lack of information**

- Cultivars
- Fertilization and irrigation
- Pruning



Ongoing pomegranate research

- **Breeding program (Dr. Deng)**
 - 16 crosses in 2014 and more in 2017, selection, etc.
- **Disease management (Dr. Vallad)**
 - Pathogen identification, registration of new fungicides, etc.
- **Nutrient management**
 - Soil/tissue analysis, fertilization recommendations, etc.



NPK recommendations for pomegranate

Age (year)	Recommendation rate (lb/tree)		
	N	P ₂ O ₅	K ₂ O
1-2	0.3-0.5	0.3-0.50	0.5-0.6
3	0.5-0.7	0.50	0.6-0.8
4	0.7-1.0	0.50	0.8-1.2
+5	1.0-1.5	0.50	1.2-1.8

Leaf sampling for tissue analysis



Report Number: [REDACTED]

Lab No: 105032

Send To: Highland Precision Ag
Dr. Tyler Jacoby
590 3rd Street NW
Mulberry, FL 33860

Waypoint ANALYTICAL

PLANT ANALYSIS

590 NW 3rd St, Mulberry, FL 33860
Main 863.425.0273 * Fax 863.425.0298
www.waypointanalytical.com

HIGHLAND PRECISION AG

Customer Account Number: [REDACTED]

Grower: [REDACTED]

Report Date: 12/5/2017
Page 1 of 5

Field id: [REDACTED] Crop: **Strawberry - Florida**

Sample Id: [REDACTED] Growth Stage: **Initial harvest** Plant Part:

	Nitrogen %	Sulfur %	Phosphorus %	Potassium %	Magnesium %	Calcium %	Sodium %	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm
Analysis	3.09	0.28	0.42	1.06	0.35	0.87	0.03	32	22	59	51	4	22
Normal Range	2.40	0.15	0.25	1.00	0.25	0.70	0.05	25	30	50	60	5	10
Range	3.59	0.35	0.35	2.59	0.40	1.50	0.19	100	81	251	200	13	250

	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Ca/B	Fe/Mn	Ca/K	Ca/Mg
Actual Ratio	11.0	2.9	1.5	190.9	3.0	179.7	271.9	0.9	0.8	2.5
Expected Ratio	12.0	1.7	1.2	54.1	5.5	119.3	176.0	0.9	0.6	3.4

Very High	High	Sufficient	Low	Deficient	N	S	P	K	Mg	Ca	Na	B	Zn	Mn	Fe	Cu	Al
					█	█	█	█	█	█	█	█	█	█	█	█	█

Comments:

02028) These plants are low or deficient in copper. Low copper availability may be caused by high soil organic matter, high soil pH, or sandy soils with low organic matter. Copper may be foliar applied at .5 to 1 lb per acre. If a chelated material is used, apply according to manufacturer specifications. Repeated application may be necessary.

02027) These plants are low or deficient in iron. Possible causes include low iron availability or high soil pH. Iron may be a foliar applied at 1 to 2 lbs per acre. If a chelated material is used, apply according to manufacturer specifications. Repeated applications may be necessary.

02026) These plants are low or deficient in zinc. Possible causes include low zinc availability, high pH or high soil phosphorus levels. Zinc may be foliarly applied at 0.5 to 1 lb per acre. If a chelated material is used, apply according to manufacturer specifications. Repeated applications may be necessary.

Analysis prepared by: Waypoint Analytical Florida, Inc.

Interpreting leaf tissue analysis

	Sufficient level	Farm 1		Farm 2	Farm 3
		Normal	Tip-burn		
N (%)	1.8-2.5	1.97	1.96	2.00	2.10
P (%)	0.1-0.2	0.19	0.18	0.17	0.39
K (%)	1.5-2.2	1.11	1.14	0.67	1.40
Ca (%)	1.5-2.0	1.08	0.99	1.45	1.60
Mg (%)	0.3-0.4	0.27	0.25	0.42	0.41
Mn (ppm)	20-70	36	34	28	106
Zn (ppm)	40-70	27	23	11	17
Fe (ppm)	60-120	64	11	31	66
B (ppm)	10-20	14	15	19	17
Cu (ppm)	10-20	4	5	4	7

Iron deficiency

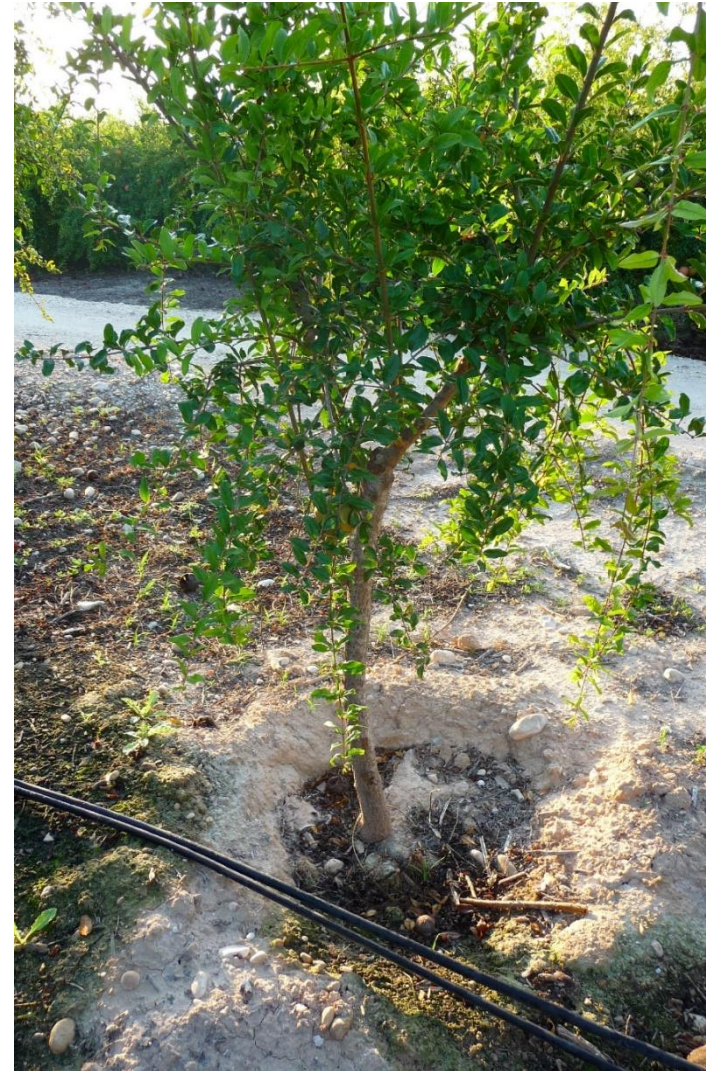


Pruning to manipulate tree architecture

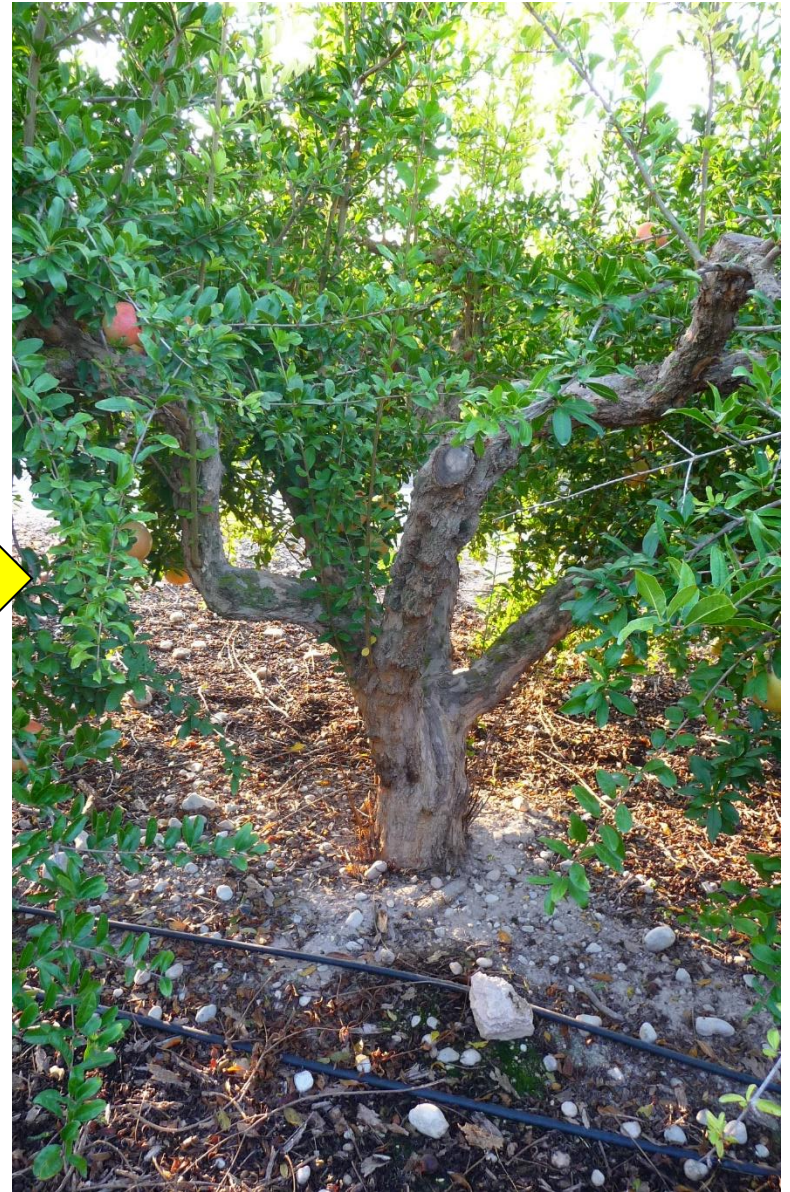
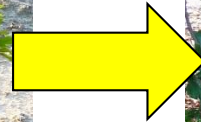
Multiple trunks (US)



Single trunk (Spain)



Single-trunk system in Spain





Hops



Opportunities...

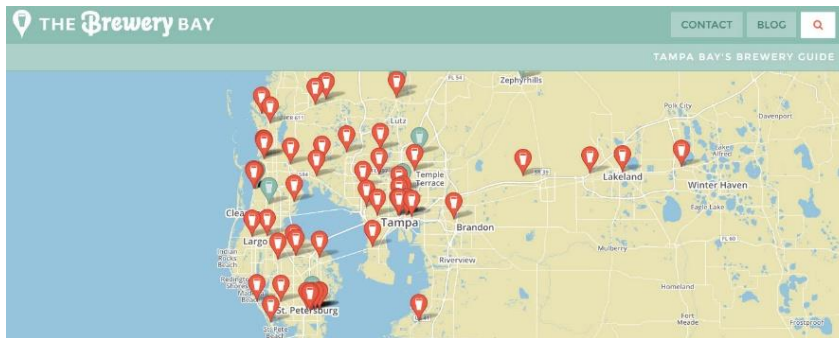
- **Rapidly growing craft beer industry**

- 12% market share of the overall beer industry
- Breweries in Florida: 45 (2011) → 182 (2016)
- Craft beer production: 5.4 MG (2013) → 37 MG (2015)
- Economic impact: \$876 million (2013) → \$2 billion (2015)

- **Increasing grower price**

- \$1.94/lb (2005) → \$5.72/lb (2016)

- **High demands for locally produced hops**



Hops vs. Florida's major crops

Crop	Grower price (\$/lb)	Production value (\$/acre)
Strawberry	2.05	42,025
Pepper, Bell	0.55	16,255
Bueberry	3.35	15,109
Tomato	0.53	13,650
Hop (US)	5.72	9,801
Cabbage	0.18	6,256
Watermelon	0.16	5,555
Cucumber	0.30	5,393
Squash	0.45	5,187
Cantaloupe	0.19	5,157
Sweet Corn	0.32	4,640
Snap Beans	0.72	3,960
Potato	0.16	3,784

Insufficient photoperiod in Florida

Optimum environment

- Latitude 35-55°: >15 hr daytime until early summer, <15 hr thereafter
- Yakima Valley, WA: 46°, max daytime 15 hr 51 min
- Vegetative growth (>15 hr) → flowering (<15 hr) → high yield in a single harvest

Florida

- Tampa: 28°, max daytime 13 hr 46 min
- Immature flowering → limited vegetative growth → low yield and multiple harvests



Other challenges...

- **Diseases and pests**

- Viruses (Apple Mosaic Virus and more)
- Downey mildew?
- Aphids, mites, armyworms, root knot nematodes, and more?

- **Lack of information**

- Cultivars
- Cultural practices (planting density, fertilization, etc.)

Hop yard at GCREC



Apr 8, 2016



Apr 22, 2016



July 11, 2016



Cascade



Nugget



Centennial



CTZ



Chinook



Fuggle



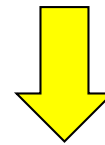
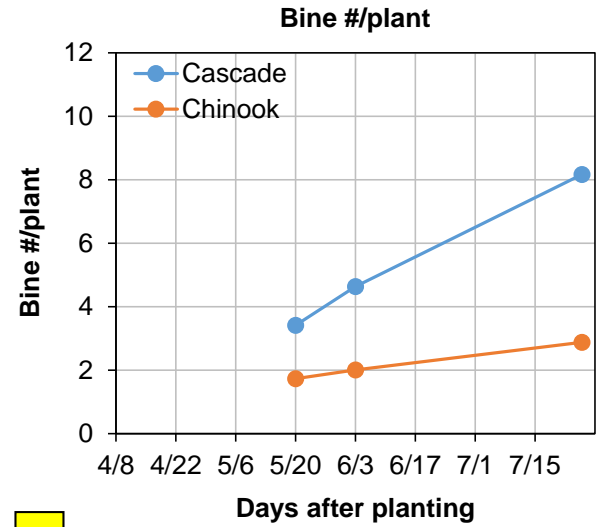
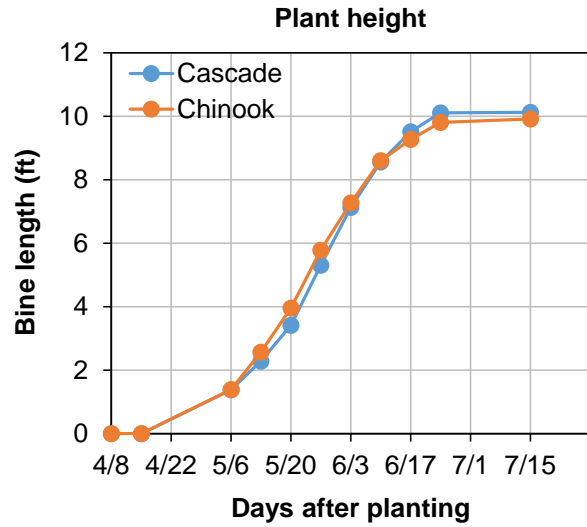
Perle



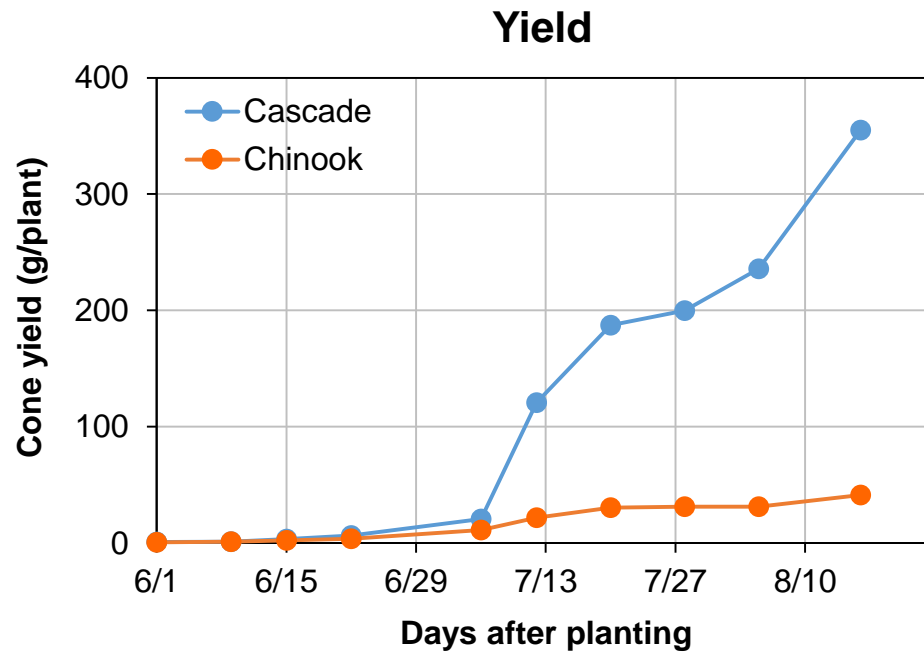
Willamette



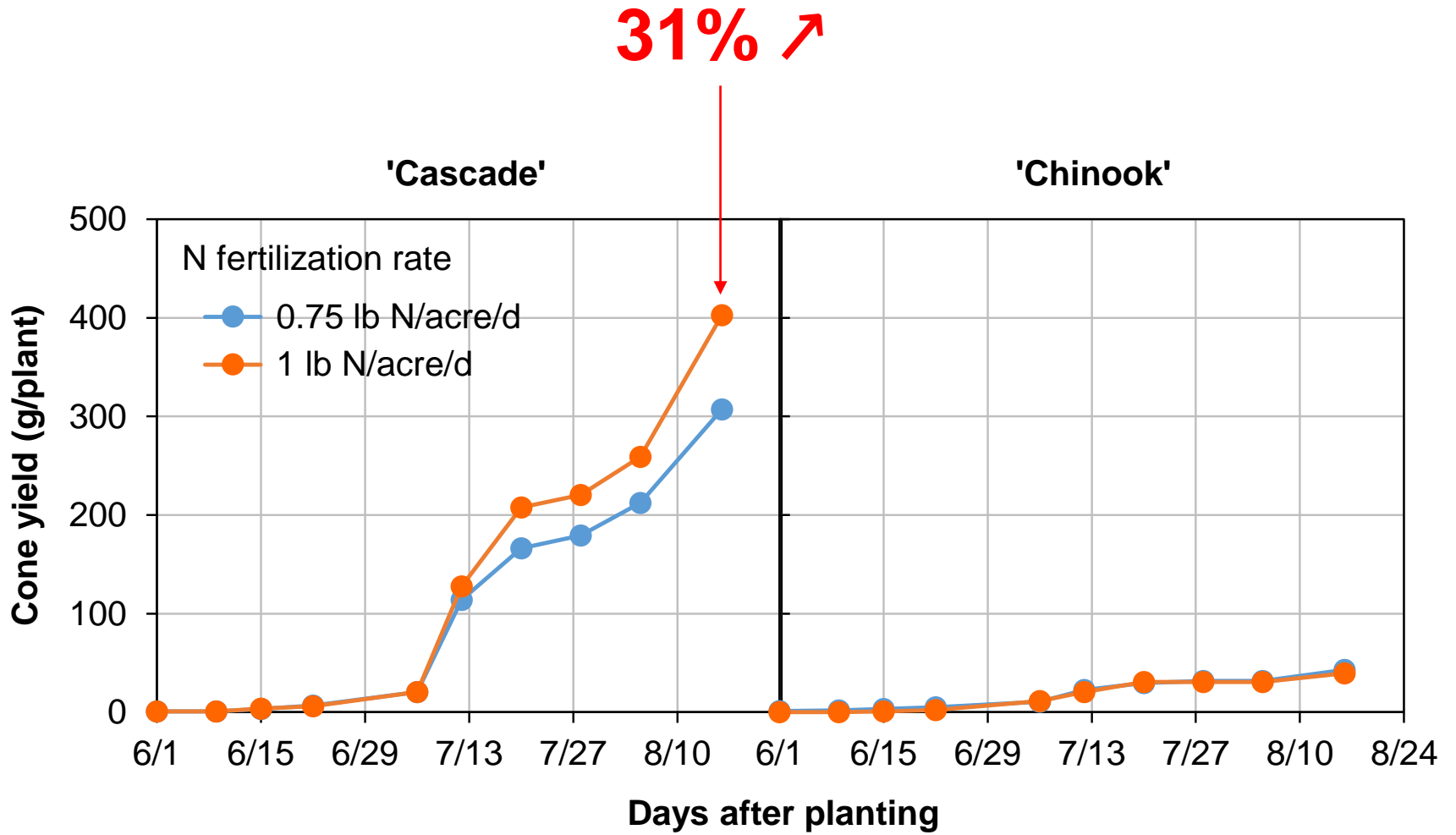
Cascade



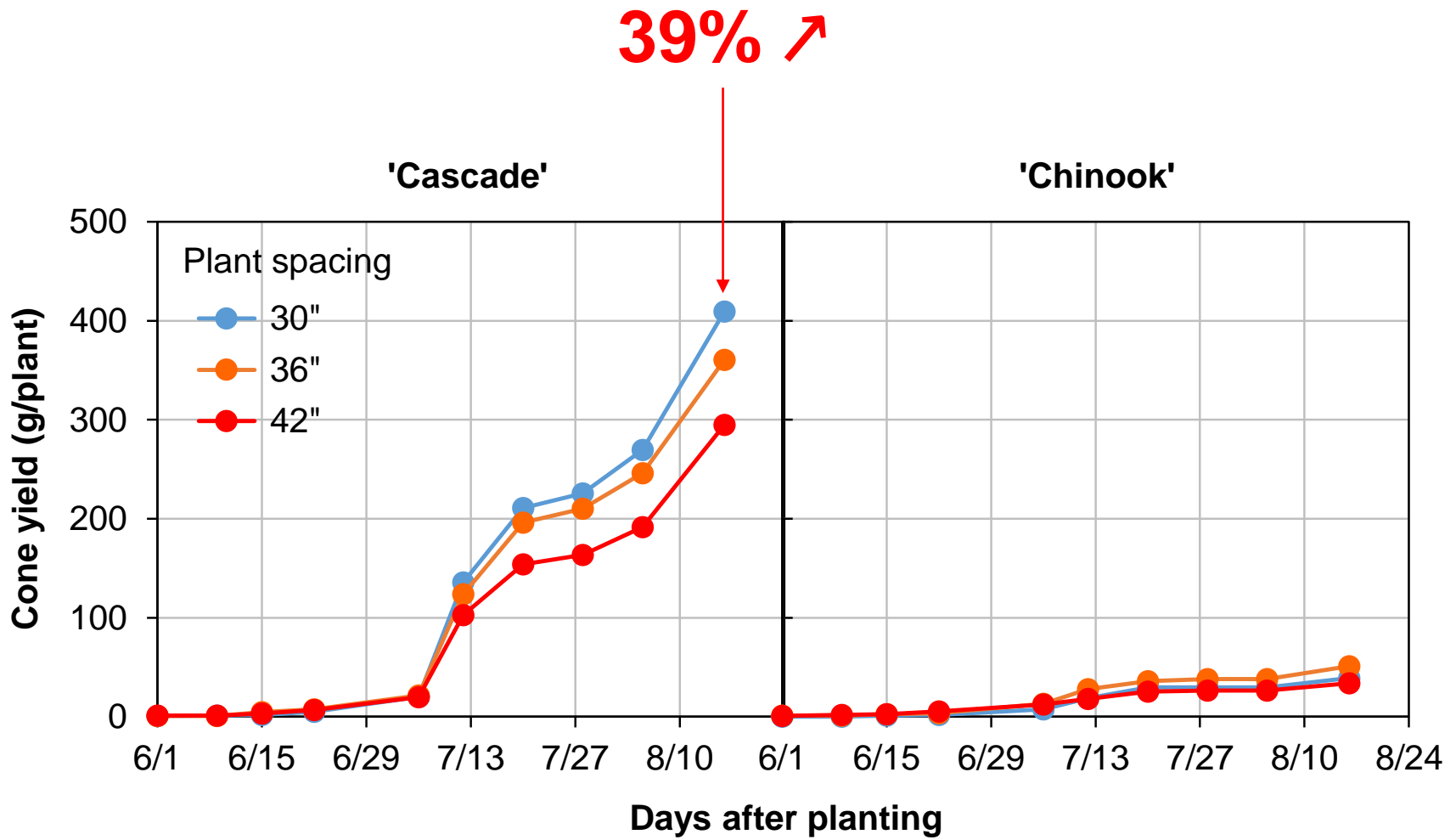
Chinook



Yield response to N fertilization



Yield response to plant spacing



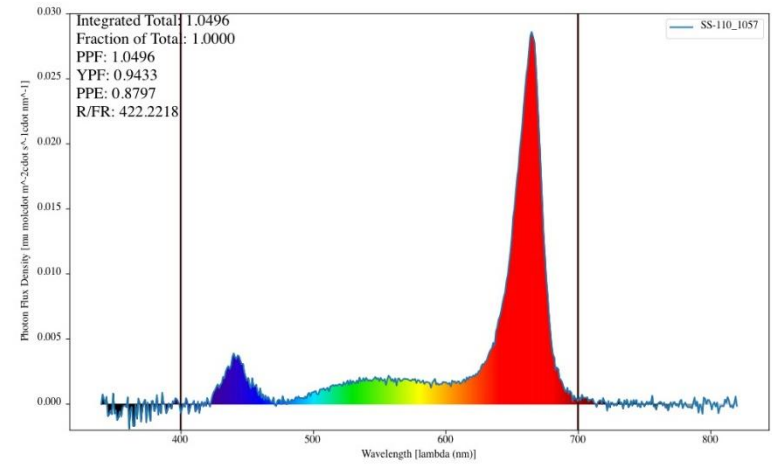
10/31/16



Rhizomes vs. Tissue culture seedlings



LEDs for day length extension



Our strategies...

- ✓ Select cultivars – yield, quality, disease resistance, etc.
- ✓ Develop disease management options
- ✓ Optimize management practices
- ✓ Develop optimal pruning practices (pomegranate and blackberry)
- ✓ Hormone application to overcome chilling requirements (artichoke and blackberry)
- ✓ Photoperiod manipulation by artificial lighting (hops)

Acknowledgements

Collaborators

- Drs. Zhanao Deng, Gary Vallad, Hugh Smith, Johan Desaegeer, and Brian Pearson
- Mr. Simon Bollin and Ms. Sonia Tighe
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- Florida Specialty Crop Foundation
- Florida Pomegranate Association
- Quick Starts



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- Anthony Ellis (Field technician)
- Evangelon James (Field technician)
- Lukas Vallad (Field technician)
- Syuan-You Lin (PhD)
- Stephen Deschamps (MS)
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