Plant growth regulators to rejuvenate health of HLB-affected trees

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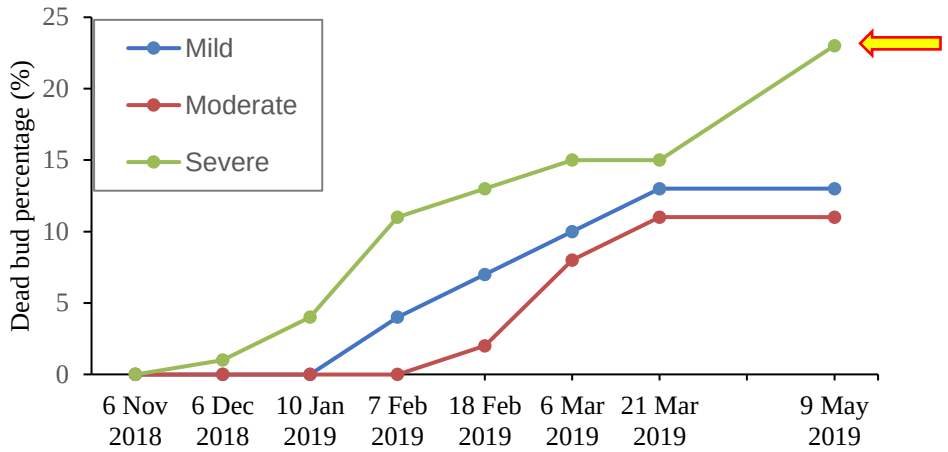
Take home message

- More leaves = more potential for fruit production
- Timely PGR application is critical for the desired benefit
- Gibberellic acid can improve yield efficiency in Hamlin and Valencia
- 2, 4 D is showing promising results in reducing fruit drop
- Cytokinin maybe be helpful

Why fewer fruit on HLB-affected trees?

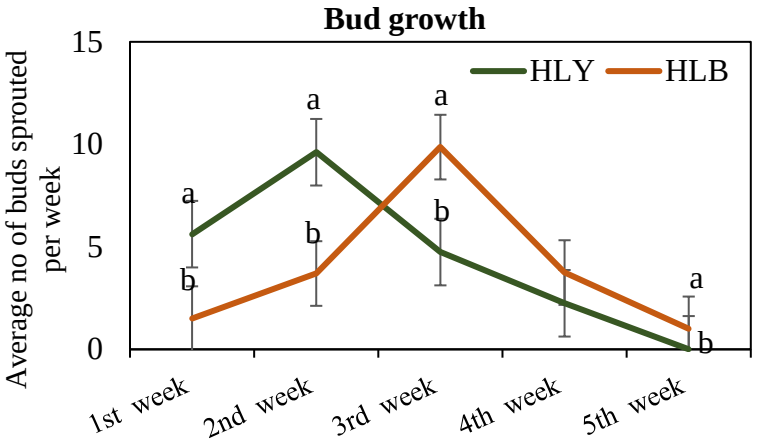
- A branch of healthy and HLB trees set the same amount of flower and fruit
- Major reason for reduced fruit production is the unavailability of fruiting wood
- Higher dieback with an increase in disease severity

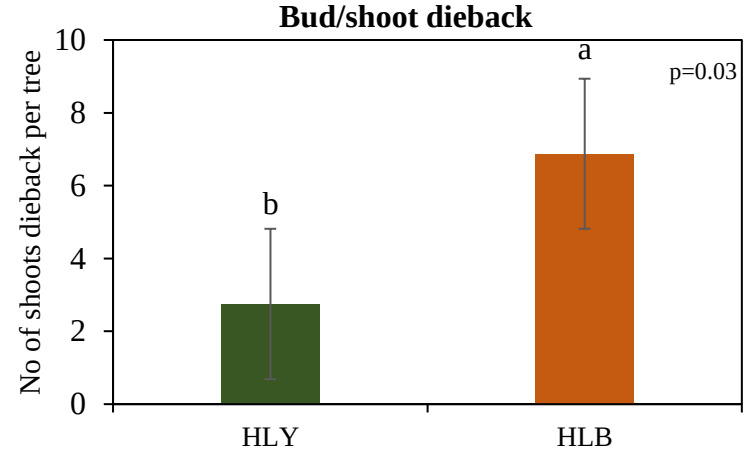


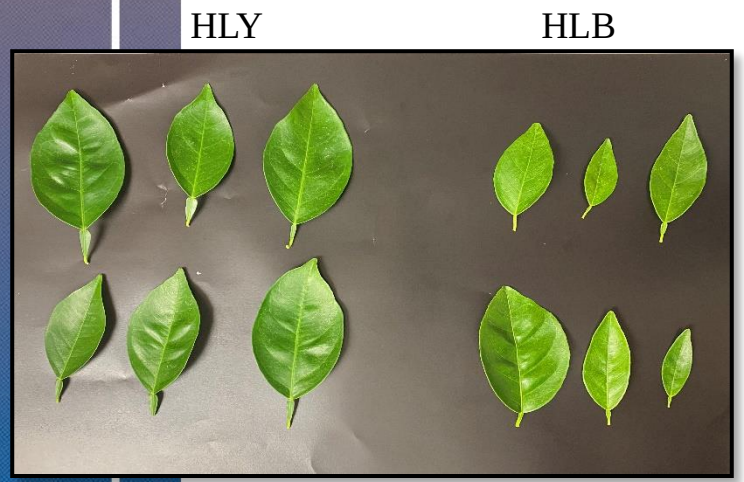
Impact of HLB on leaf growth

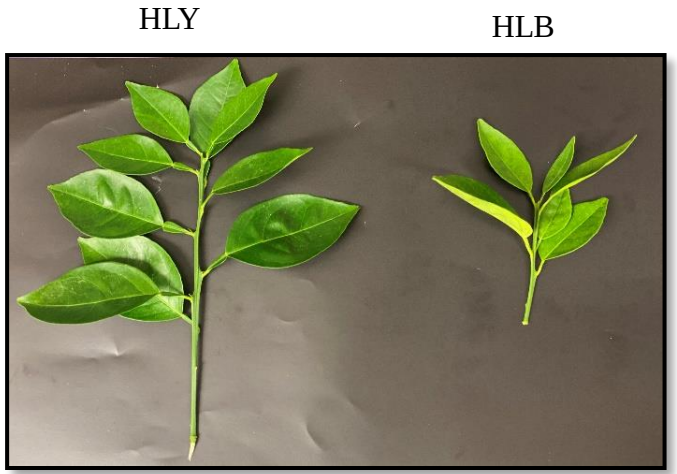
HLB-affected trees show dieback but what else:

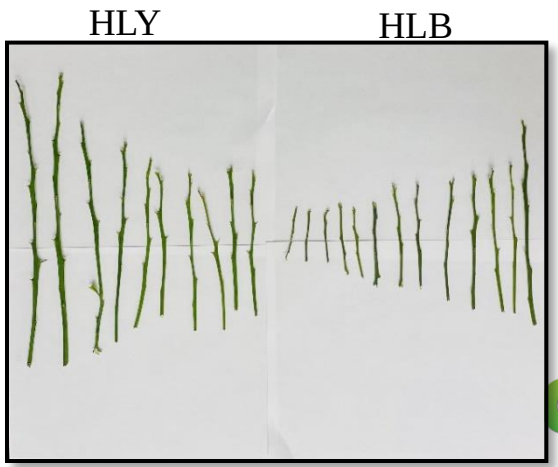
1. Delay in bud-break , higher bud-dieback
2. Fewer leaves per shoot
3. Leaves are about 2 times smaller & 50% lighter
4. Reduced tree height, small shoots
5. Higher leaf drop (8% vs 0.6%)

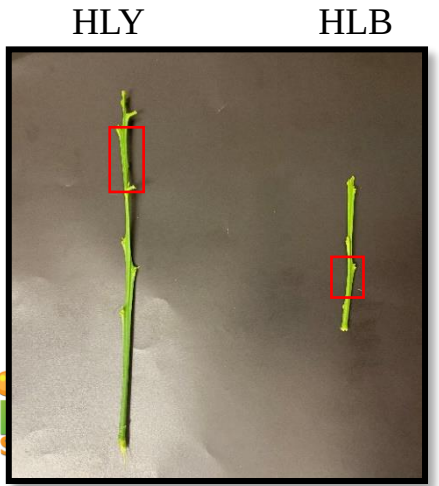










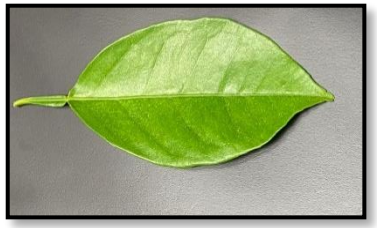


Why HLB-affected trees lag in growth?

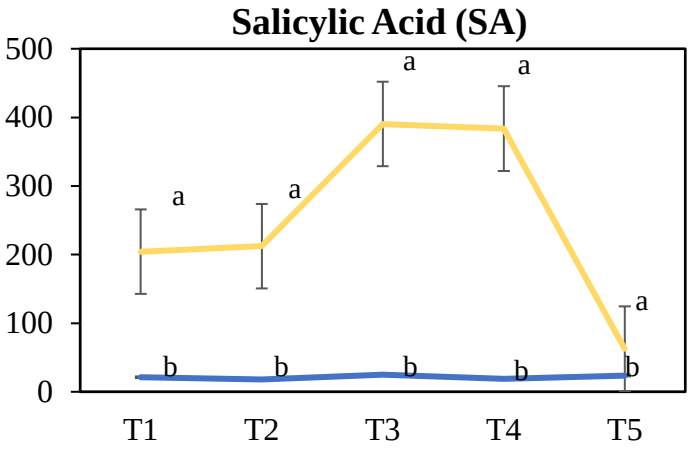
Buds (**T1 & T2**)

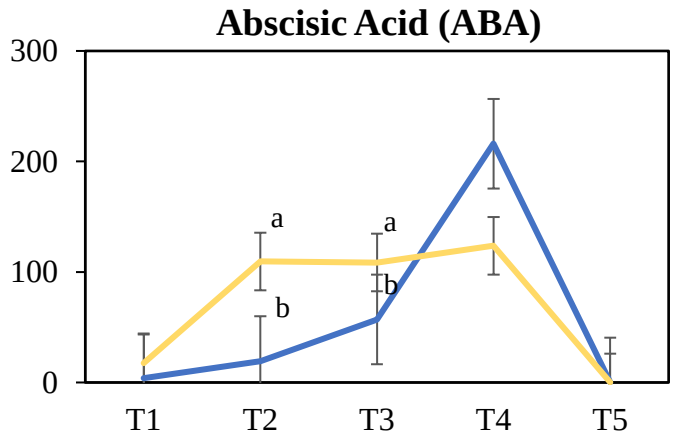
Newly emerged leaves (**T3**)

Expanded leaves (**T4**)

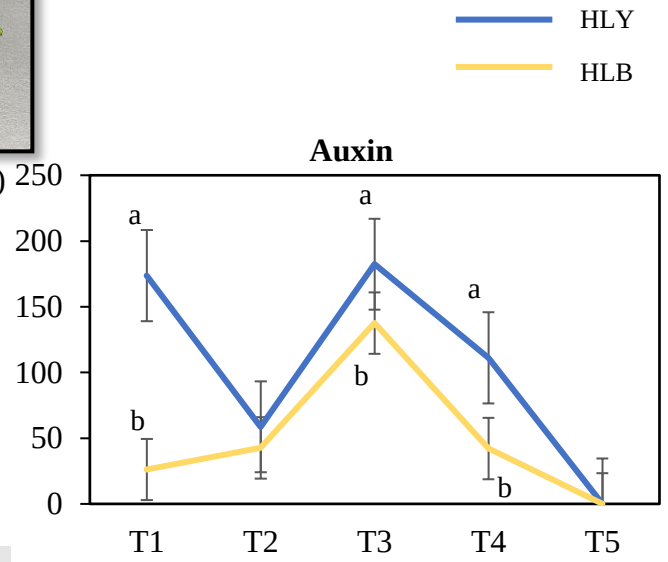


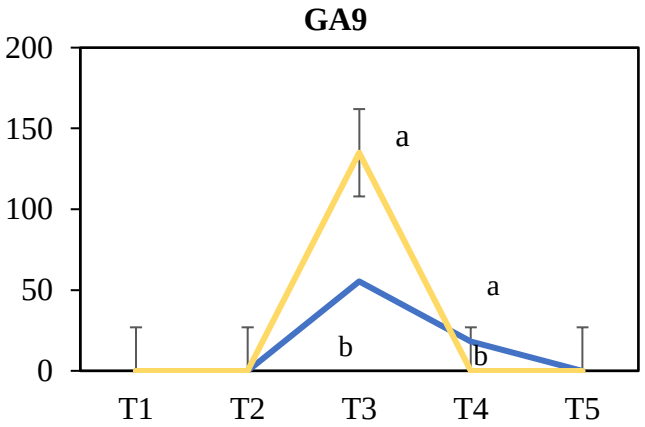
Fully mature leaves (**T5**)





Class	Associated Function(s)
Auxins	Cell differentiation
Gibberellins	Elongation
Cytokinins	Cell division
Ethylene	Ripening, abscission, and senescence
Abscisic acid	Seed maturation, dormancy
Jasmonates	Plant defense
Salicylic acid	Systemic Acquired Resistance (SAR)





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Exogenous PGR application

- We know there is hormonal imbalance due to HLB
- HLB trees lag in growth
- Strategies to improve growth should improve yield (may take a year or two)
- Auxin, GA, and cytokinin are growth promoting hormones

Valencia Orange Field Study (2016-2022)

Trees treated with multiple GA applications (20 g ai, Sep-Jan) produced more fruit

5 year average

	pounds/tree	Boxes per tree	p value
Control	172 b	1.9	0.05
GA	220 a	2.4	

Extrapolation (150 trees/acre)

	Boxes per acre
Control	287
GA	367

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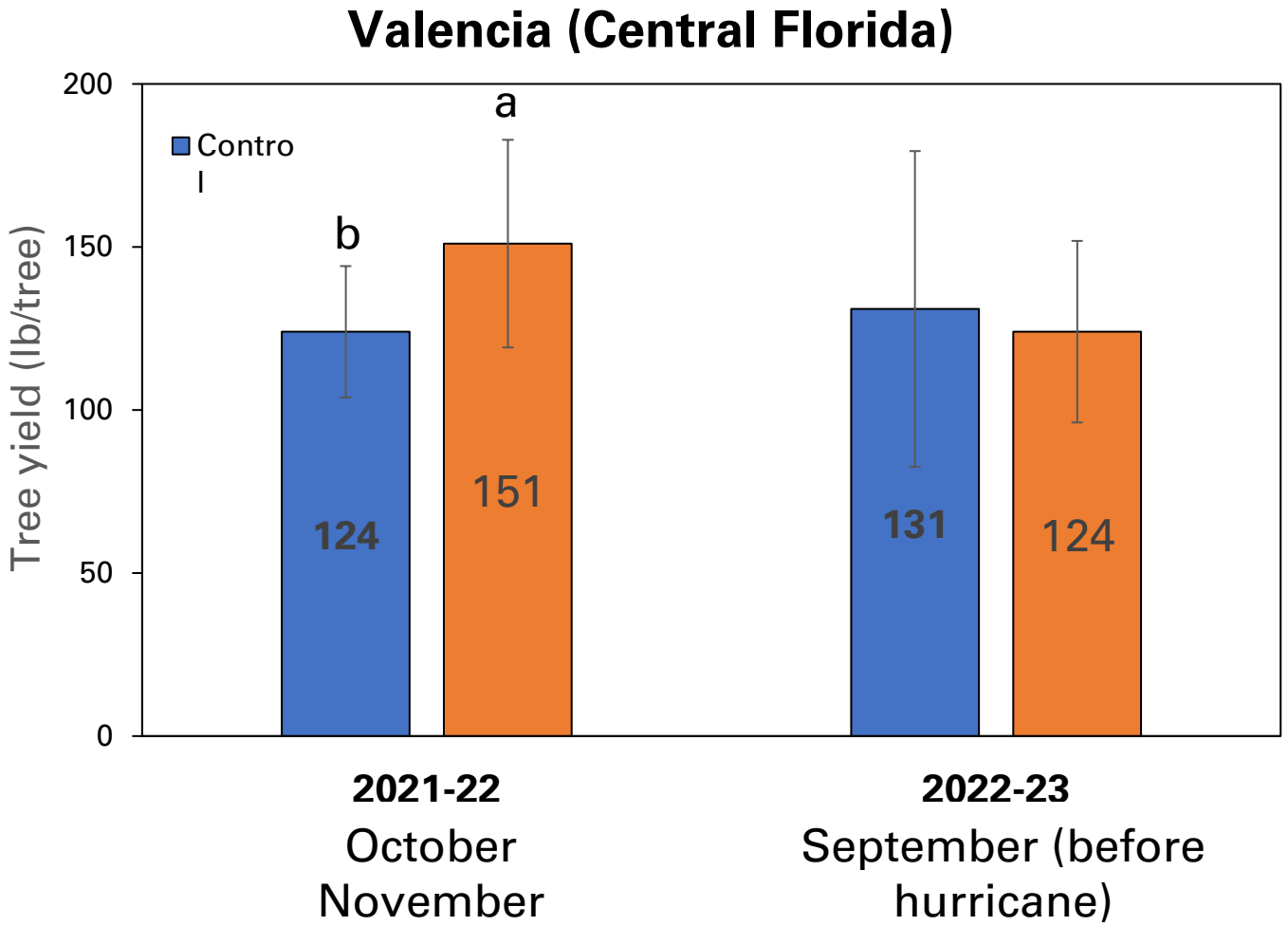
GA Grower Trials

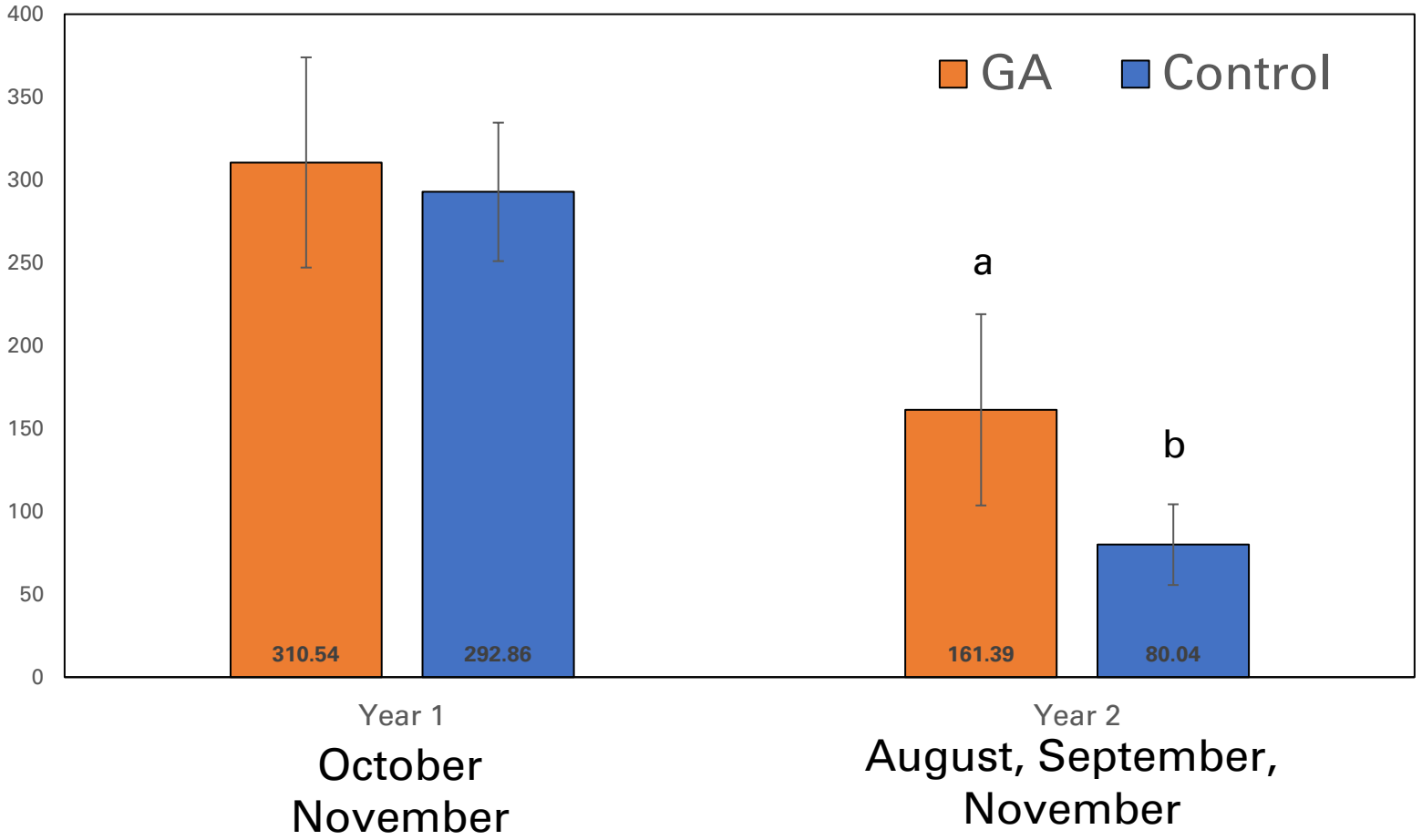
- Data from 4 sites for two consecutive years
  - 1 Valencia
  - 3 Hamlin
- Grower sprayed half block with GA (10 fl oz per acre with adjuvant) and left other half untreated
- Ten trees were selected on each side. Same trees from year 1 to 2 were monitored for yield and canopy

GA Grower Trials

- Grower sprayed GA (+adjuvant) in Fall using air blast sprayer



Site 1 Hamlin
Yield (lbs per tree)



The reduction in yield from year 1 to 2 in both sites is likely due to hurricane Ian

Site 3 (Hamlin)

- GA application
  - 2021: Aug, Sep, Nov
  - 2022: Aug, Sep, Nov (extensive hurricane damage)
    - 2, 4-D application at 3 oz per acre, one week after the hurricane

	2021	2022	2021	2022	
	Yield (lbs/tree)	Yield (lbs/tree)	FDF (December)	FDF (August)	FDF (November)
Control	316 b	34.7 b	5.49 b	6.0 b	5.26 b
GA	380 a	52 ab	7.05 a	6.74a	5.54 b
GA + 2,4 D (post hurricane treatment)		**68.03 a**			**7.07 a**

Observation: 1-2 months after the hurricane, very few fruit were seen on untreated trees whereas GA retained more fruit

Trees harvested in January

GA on Grapefruit

- Effect on color and can we degreen the fruit?
- Ruby red
- Sprayed 3 time with Progibb (10 oz per acre + adjuvant)
  - October 18
  - November 29
  - December 20
  - Harvested on February 6, 2023

GA on grapefruit

- Use of GA enhanced vegetative growth
- The fruit harvested were greener than control
- Degreening did improve the color but the fruit were still not completely degreened
- Degreening can help, further tweaking is needed
- Spraying GA until December is not ideal for grapefruit
  - July-October


Untreated

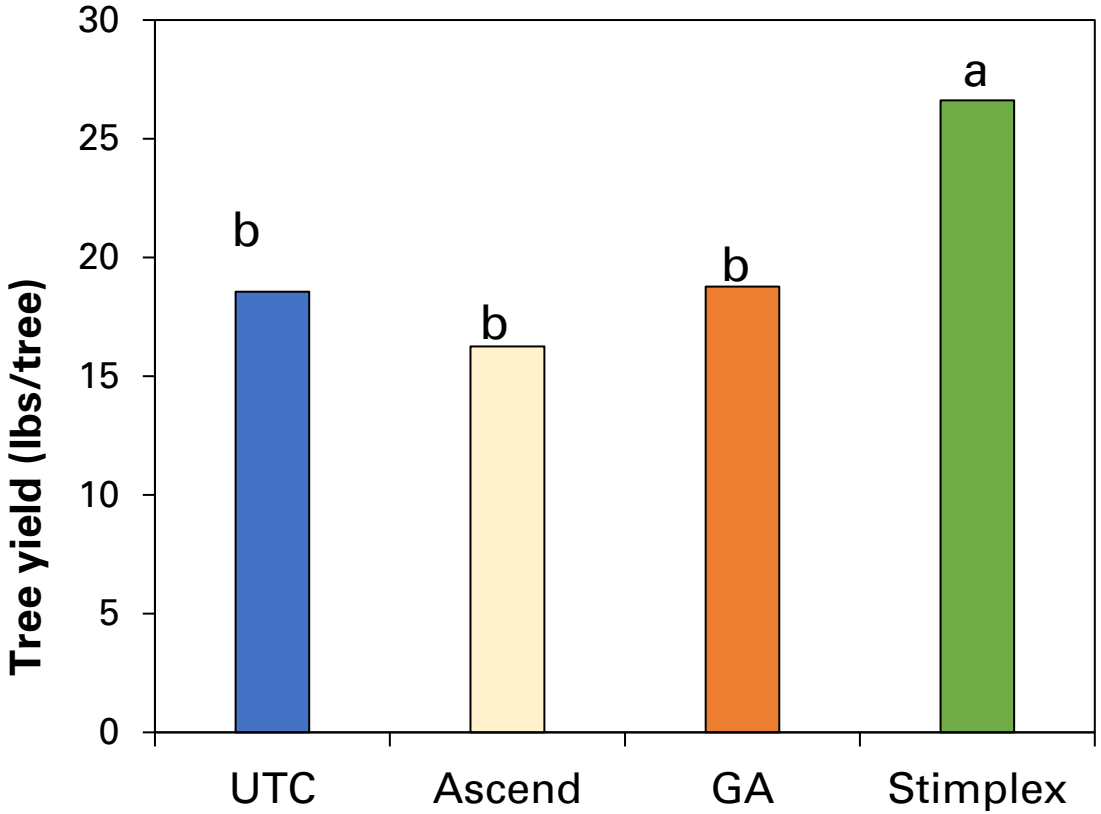

GA-treated

PGR study to rejuvenate severe trees

- Started in Spring 2022
- Severely sick trees (uniform)
- Treatments are applied every 45 day
  1. Untreated
  2. GA
  3. Ascend (contains Auxin, GA,cytokinin)
  4. Stimplex (Seaweed extract, cytokinin)
- GA and Stimplex seems promising improving growth
- Reduction in starch accumulation

	Canopy Density
	%DIF in canopy in 5 months of application
Control	0%
GA	3%
Ascend	-1.68%
Stimplex	9.02%

Stimplex-treated trees had significantly higher yield than control, ascend, and GA



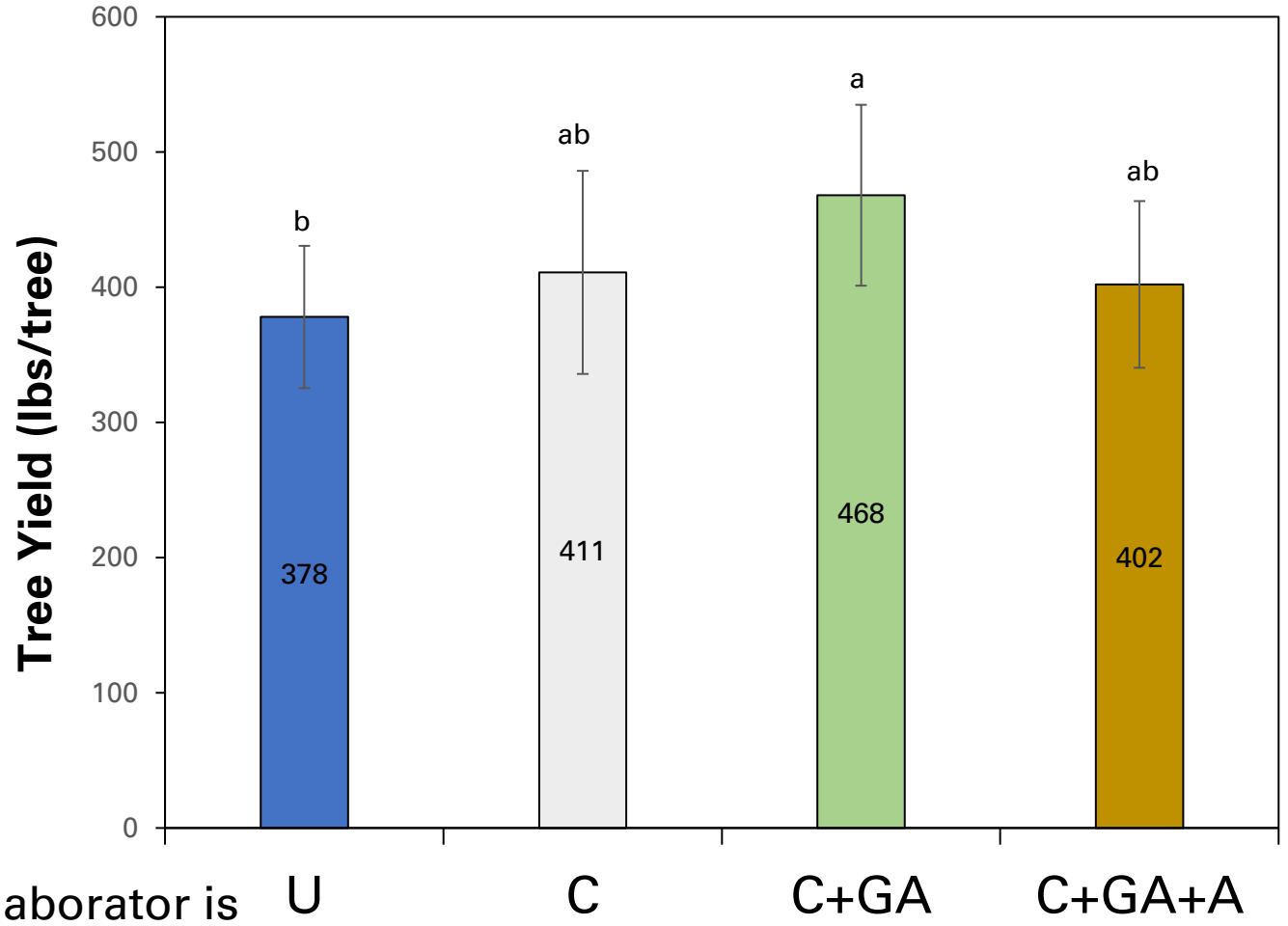
Spring application of GA is not as beneficial, possibly higher fruit set than what tree can support.

PGR combination trial

- Mature Hamlin trees (about 25 yeas old)
- Moderately HLB-symptomatic
- 4 treatments applied, starting spring
  - Validate –Cytokinin
  - Progibb-GA
  - Auxin-2,4-D

Untreated Control	**U**
Cytokinin 12oz Apr/May	**C**
Cytokinin 12oz Apr/May + Progibb Jul/Sep/Nov	**C+GA**
Cytokinin 12oz Apr/May + (Progibb + 2,4-D Jul/Sep/Nov)	**C+GA+A**

Use of Cytokinin (Spring) and GA (Summer) increased yield by approximately 90 lb/tree



The grower collaborator is applying GA with his summer sprays. So the control is also getting GA

Untreated Control	**U**
Cytokinin 12oz Apr/May	**C**
Cytokinin 12oz Apr/May + Progibb Jul/Sep/Nov	**C+GA**
Cytokinin 12oz Apr/May + (Progibb + 2,4-D Jul/Sep/Nov)	**C+GA+A**

According to first-year data, use of PGRs as per tree phenology seems promising

	Brix	Acid	Size	FDF
Untreated Control	10.9	0.68	61.1 b	6.9 b
Cytokinin 12oz Apr/May	10.3	0.73	63.1 a	7.6 a
Cytokinin 12oz Apr/May + Progibb Jul/Sep/Nov	10.4	0.69	63.3 a	7.3 ab
Cytokinin 12oz Apr/May + (Progibb + 2,4-D Jul/Sep/Nov)	10.1	0.64	62.7 ab	7.1 b

Take home message

- Gibberellic acid can improve yield efficiency in Hamlin and Valencia
- 2, 4 D is showing promising results in reducing fruit drop
- Cytokinin can boost spring and summer growth
- Degreening can work, needs more tweaking
- Tank mixing of GA with nutritionals and some insecticides is compatible
- Efficacy of day and night application is the same

Thank you!

- Citrus Initiative
- CRDF
- Dr. Mark Ritenour (and lab)
- Peace River
- Alico
- Shinn Groves
- Scott Groves
- Valent

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