Precision Nutrition Management to Rejuvenate HLB-affected Sweet Oranges

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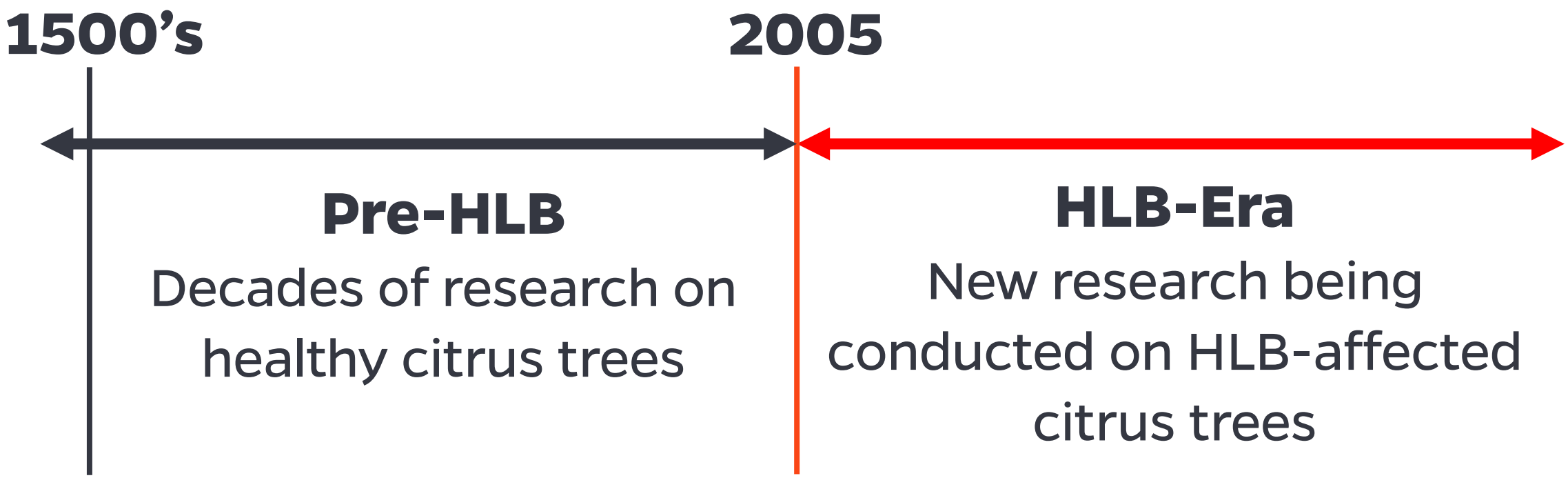
Take home message

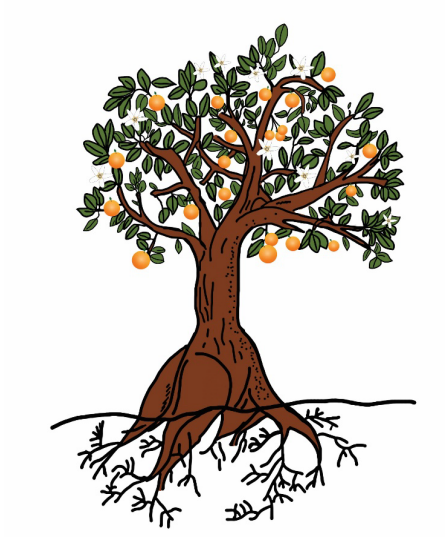
1. Leaf nutrient analysis-based fertilization on can improve the yield of trees as well as improve canopy growth
2. At least two leaf sampling (June and September) are needed to improve the canopy and fruit growth of HLB-affected trees
3. Spring leaf nutrient levels are correlated to canopy density and yield
4. A random leaf sample can be collected as the results from spring leaves random leaves are comparable
5. Fruiting and non-fruiting leaves have very different nutrient profile. Preliminary evidence suggest that fertilizing based on fruiting leaves can be considered for improved productivity

Introduction – Research Progress



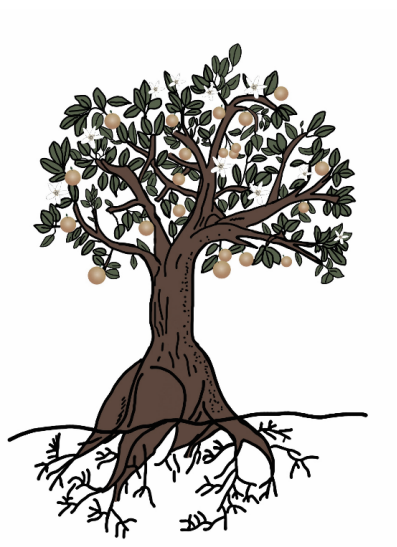
Background-Fertilizer

Healthy



Stand on their own longer between fertilizer applications

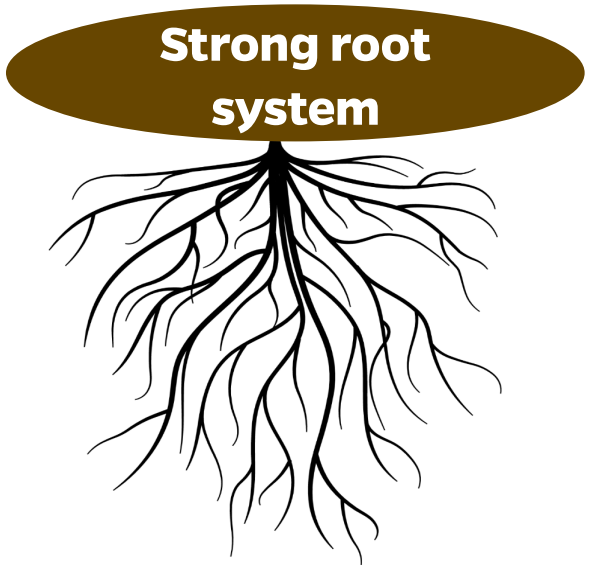
HLB-affected



Used the nutrients quicker

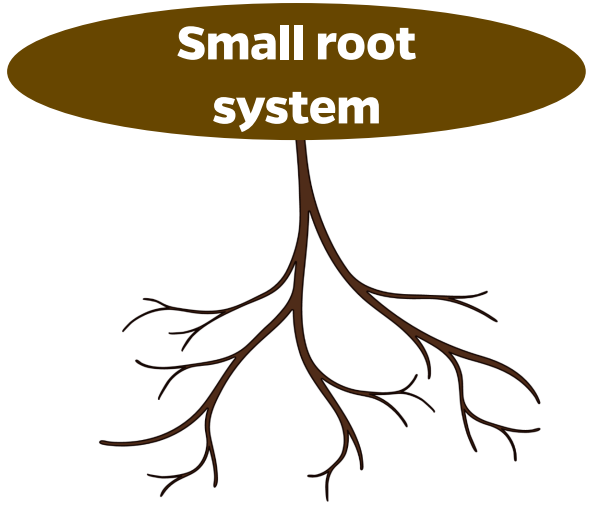
Background-Roots

Healthy



Absorption

HLB-affected



Absorption

HLB-affected trees smaller root system need a constant supply to meet nutritional needs

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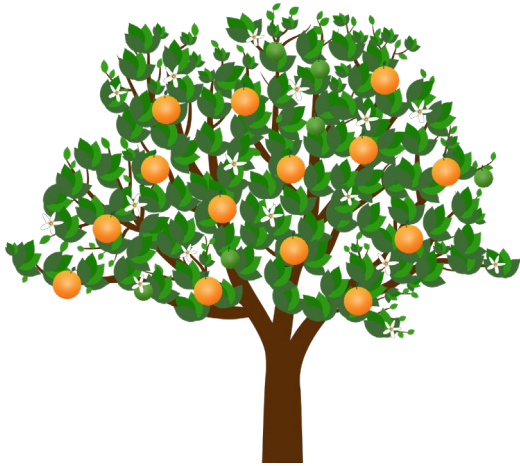
Source: Shahzad, F., et al. (2020)
Graphics: N. Thapa, K.M. Snyder, T.R. Weeks, UF/IFAS



Nutrition management in HLB-affected trees has been controversial

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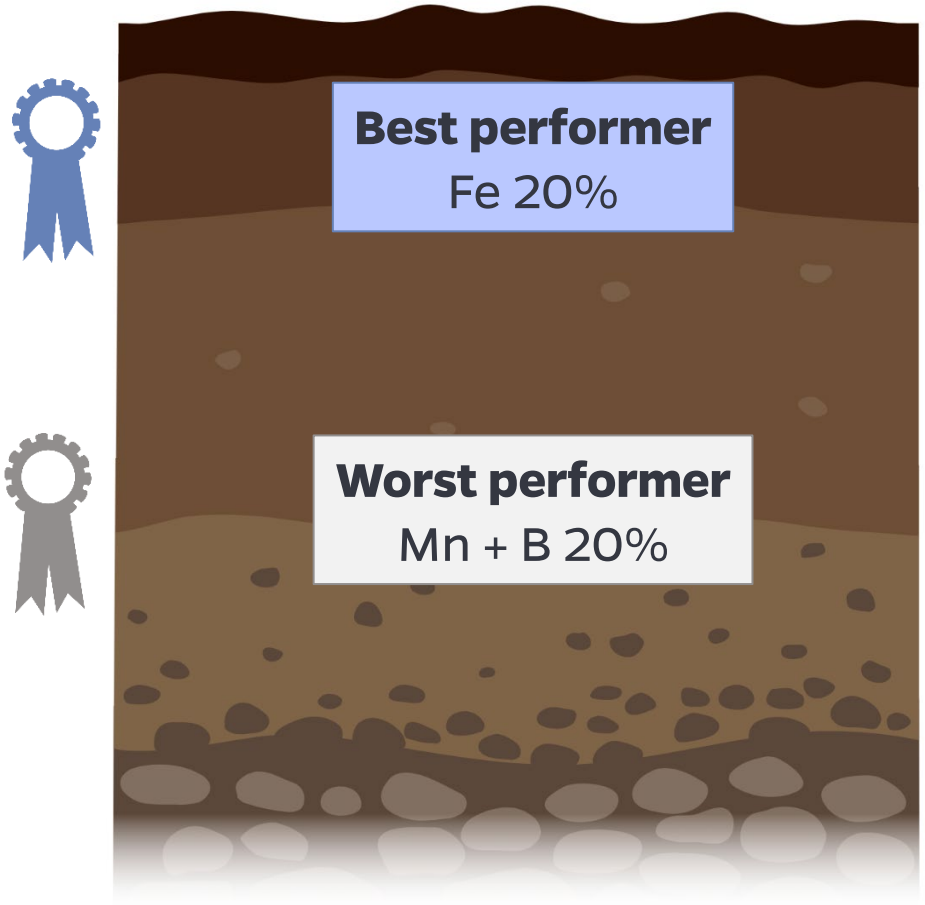
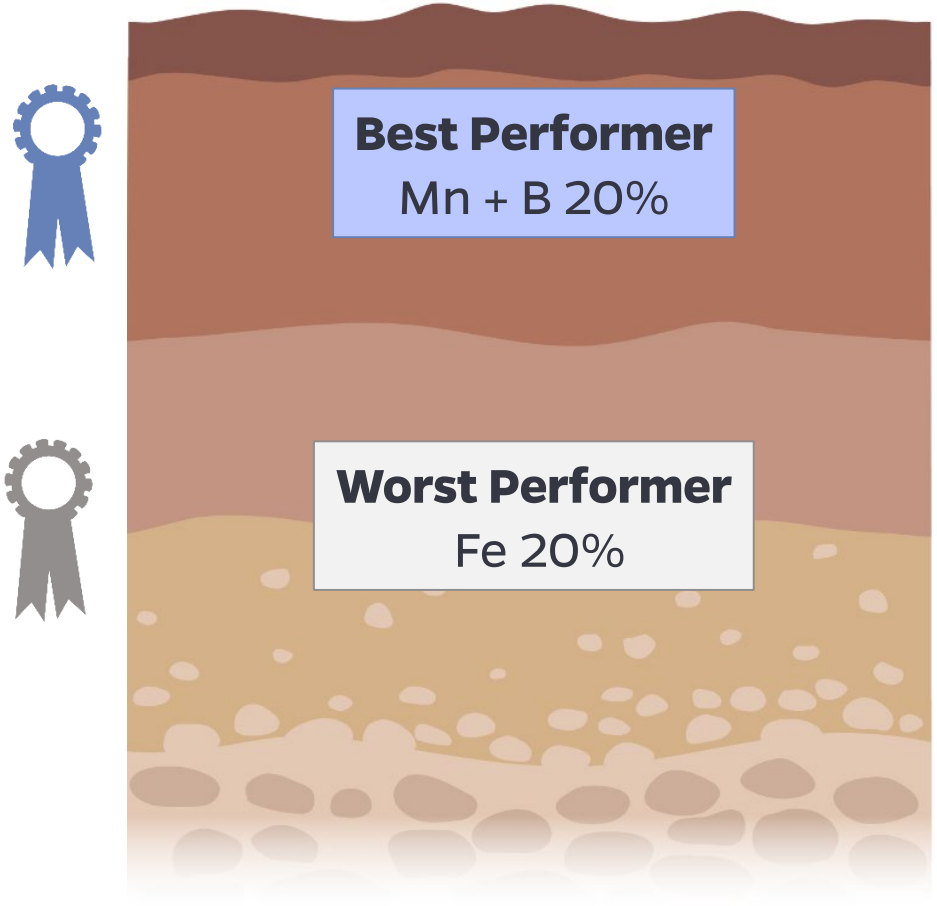
Background-Soil Type

South Florida (Flatwoods)



Central Florida (Central Ridge)



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Source: Vashisth, T. (2020); Graphics: BioRender.com

Nutrition Management: Plant Nutrient Status

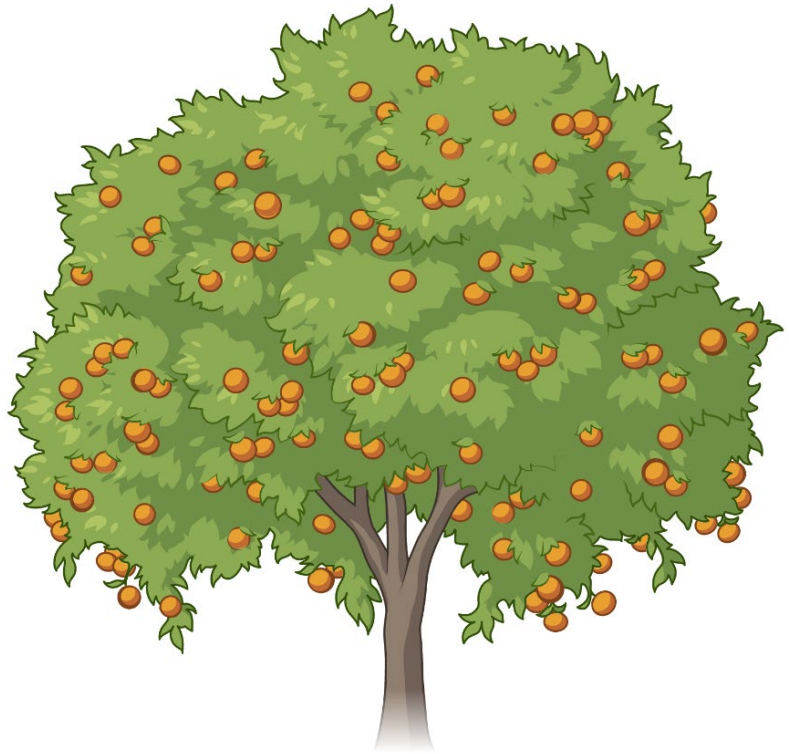
- Nutrient management for HLB-affected trees requires to determine plant nutrient status and what is lacking

- Needs accurate analysis

- Nutrient leaf sampling can be used to determine leaf nutrient concentration to create a fertilizer plan

Current Florida Sampling Method

Time
(July-Aug)



Flush
(Spring)

Age
(4-6 month)

Location
(Non-fruiting)

Leaf Sampling

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Graphic: BioRender.com; Image from Microsoft PowerPoint v. 2022

OBJECTIVE

Determine if frequent leaf nutrient sampling can be used to design nutrient management plan for improving tree productivity

How many and when nutrient analysis should be done?

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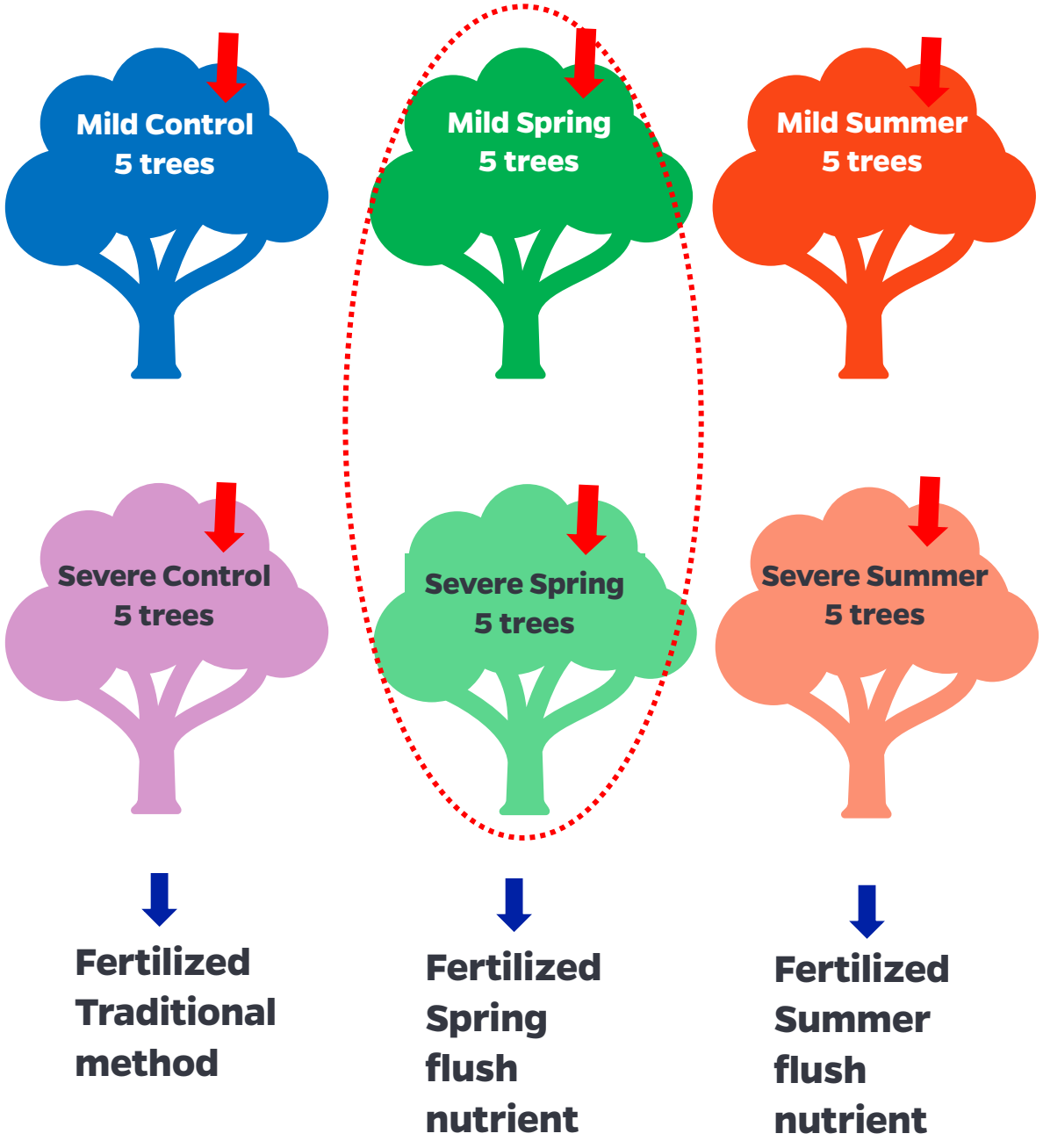
Experimental Design

- Field trials
  - Two locations: Ridge and Flatwoods
  - Two varieties: Hamlin and Valencia
  - Tree disease severity: Mild and Severe
  - Treatment: Control, Spring and Summer

- Trees were fertilized based on either spring or summer flush nutrient analysis

- For leaf nutrient analysis spring and summer emerged flush collected 4 times a year

- Experiment started: 2021
- Hurricane Ian : 2022



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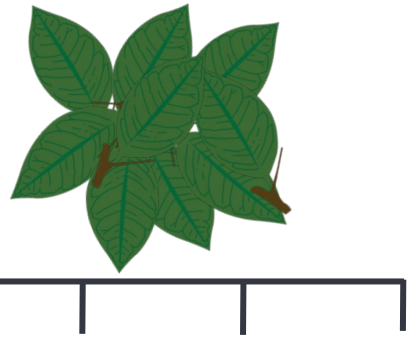
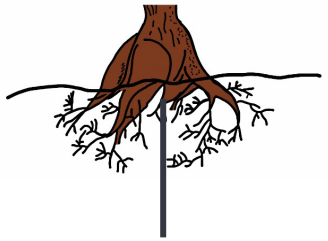
Materials and Methods



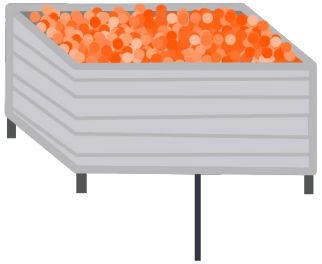
Leaf weight SPAD Leaf area Nutrient concentrations

Ct values in initial samples to confirm HLB

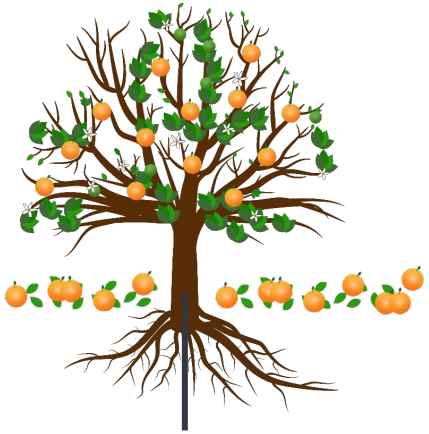
Soil nutrient concentrations



Root nutrient concentrations



Yield and brix-acid ratio



Tree density, canopy volume, and fruit drop

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Graphic Design: T.R. Weeks, UF/IFAS

RESULTS

Hamlin (Central Ridge)

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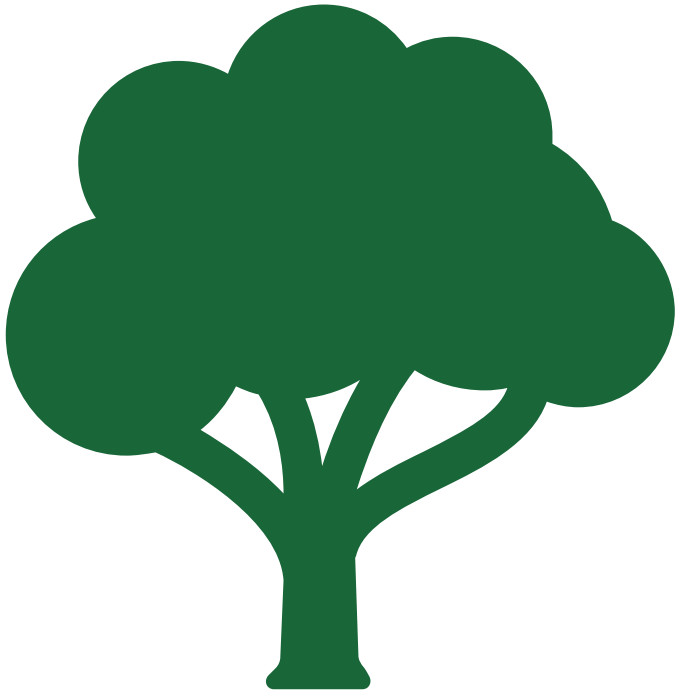
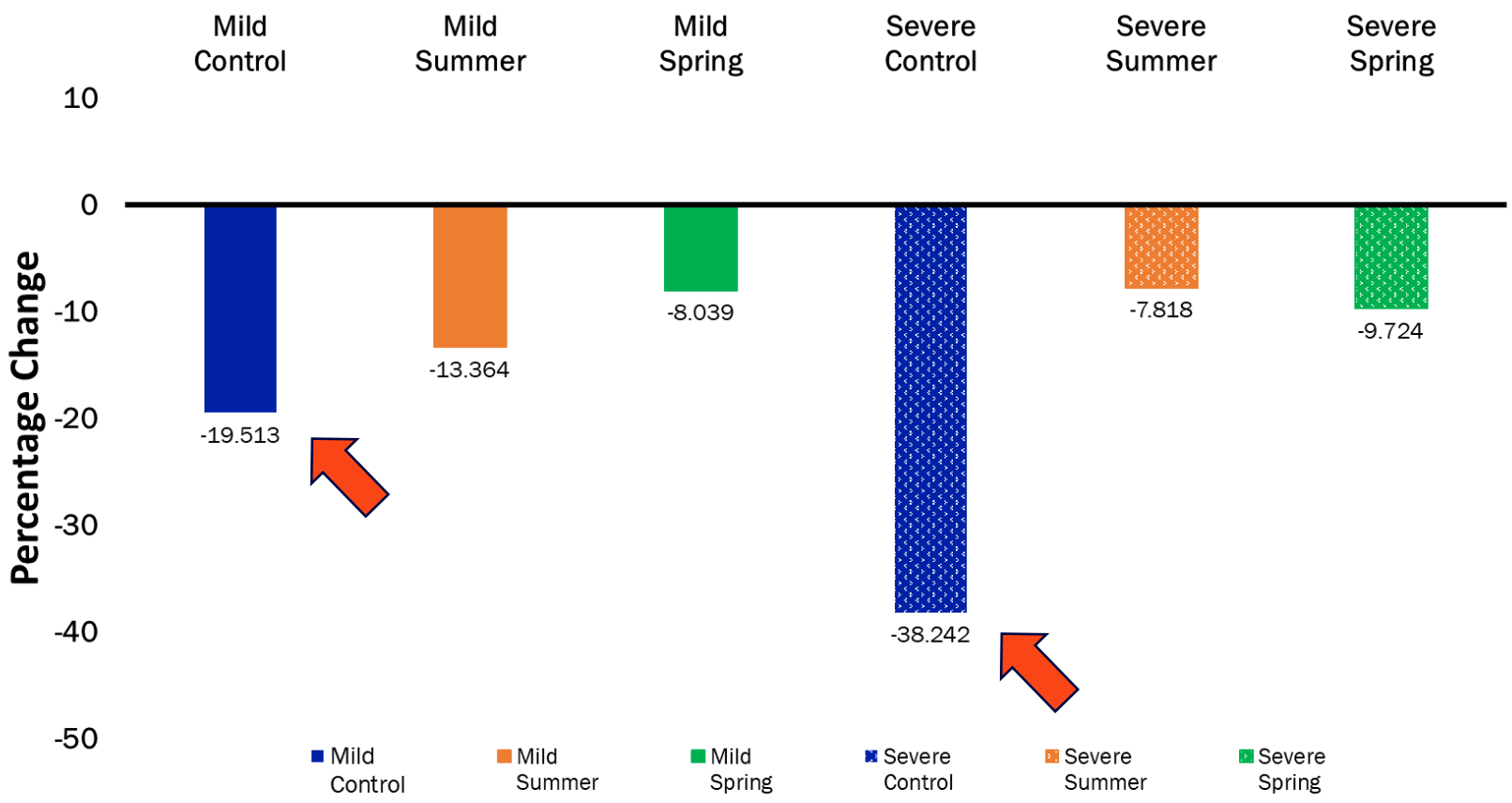
Tree Density



Did the tree density change in two years ?

Fertilization based on leaf nutrient analysis slows down the canopy decline



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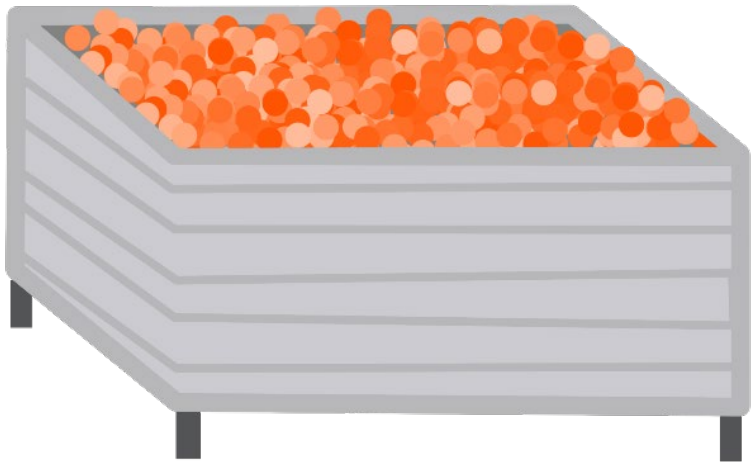
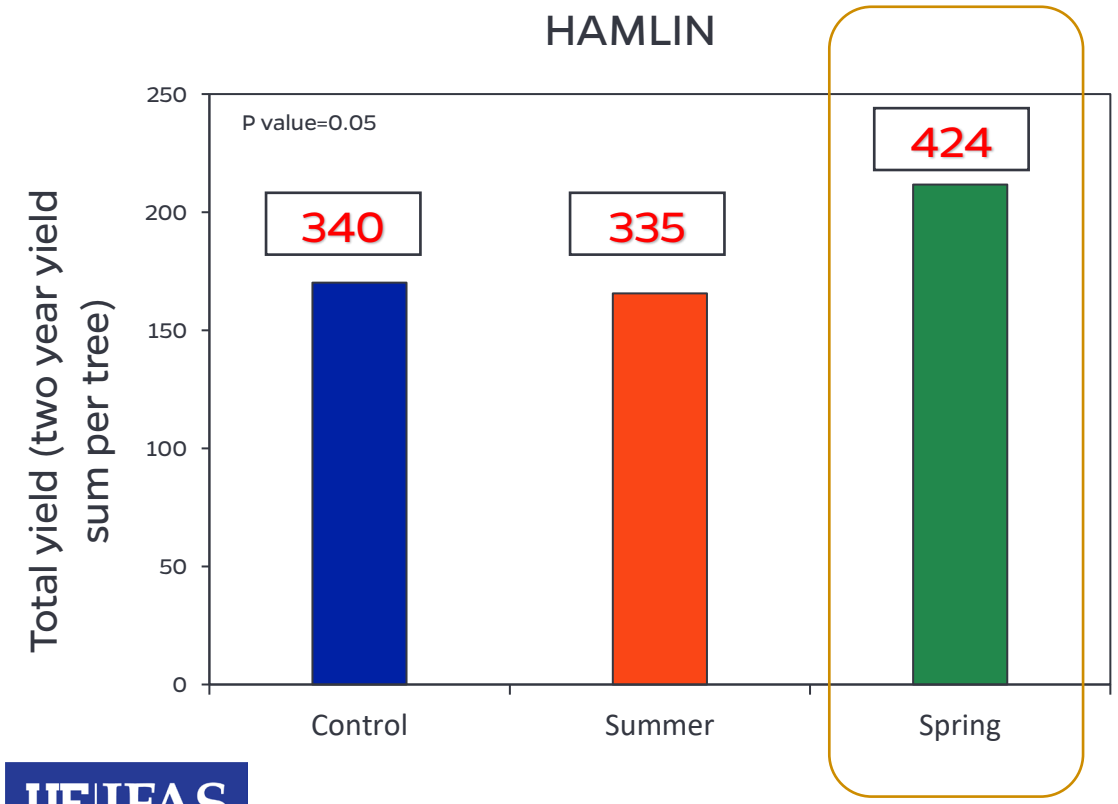
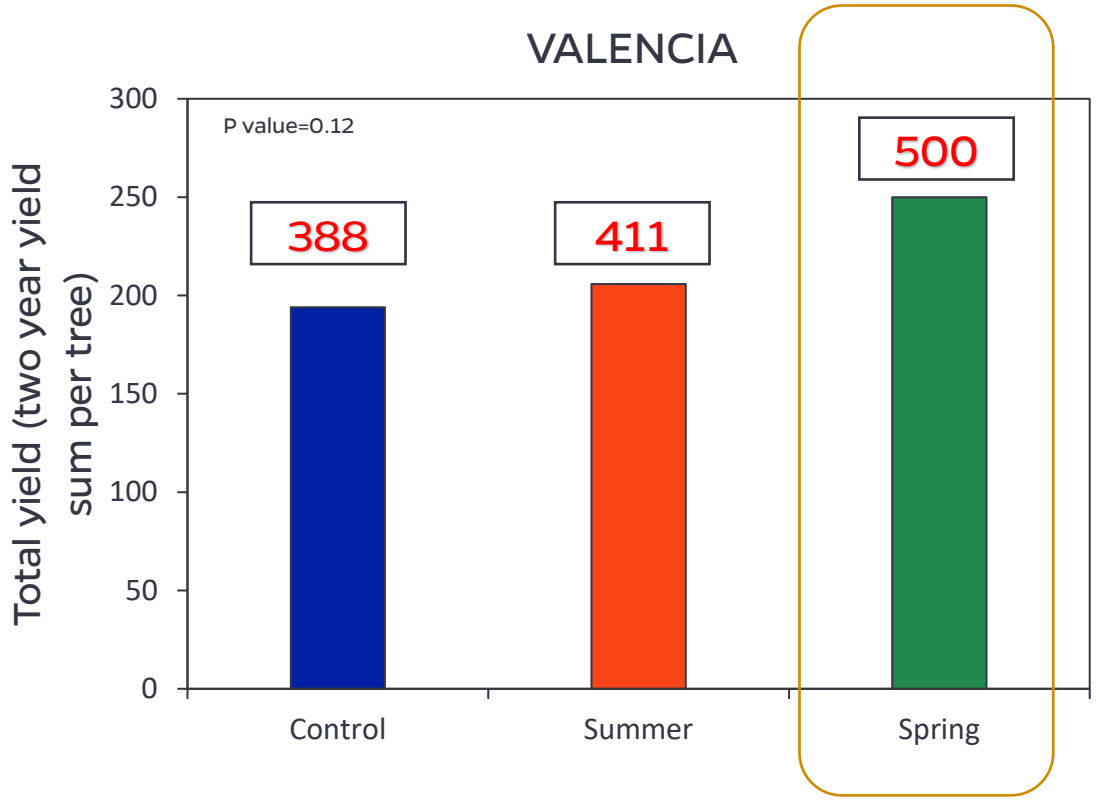
Yield



Is yield affected by leaf nutrient-based fertilization?

Fertilization based on leaf nutrient analysis improved yield in Hamlin and Valencia





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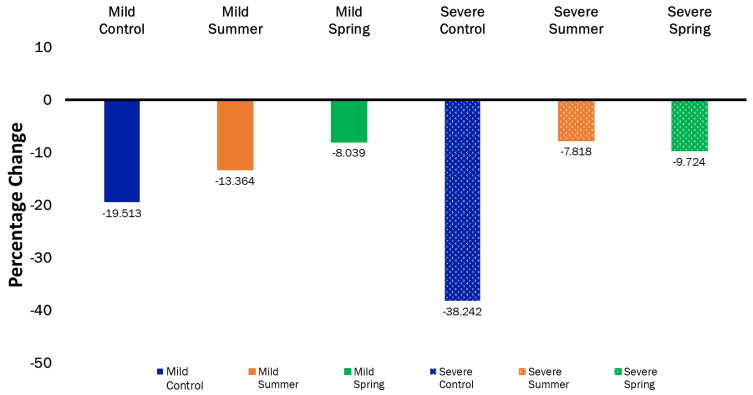
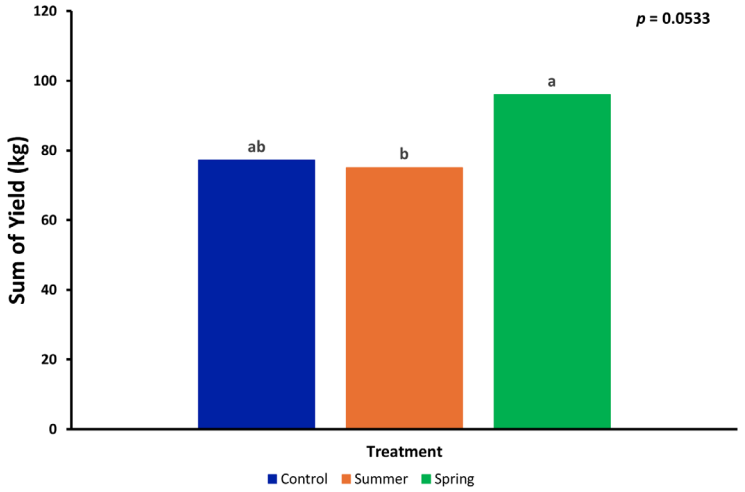
Summary– Tree Density and Yield





- Severe trees declined more than mild trees
- Spring-treated trees had less decline in canopy density; therefore, demonstrating fertilizer treatments may have an impact
- Yield was significantly affected by treatment and tree health
- Spring-treated trees performed better than control or summer in both mild and severe trees

Spring flush-based fertilizer treatment perform better

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Total Amount of Each Nutrient Applied (2021 AND 2022)

Nutrient (pounds/acre)	Mild Spring	Mild Summer
N	69	60
P	3.2	2.1
K	100	58
Ca	44	29
Mg	0	0
Mn	2.4	0
Zn	1.6	3.2
Fe	2.3	1.5
B	0.3	0.48

Validate if there is a correlation between

Yield and nutrients

Canopy density and nutrients

Why spring flush?
Can we reduce the number of nutrient analysis?
What is the most critical time?
Which nutrient contributes more?

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Methods – Analysis

- Leaf sample: 4 times a year

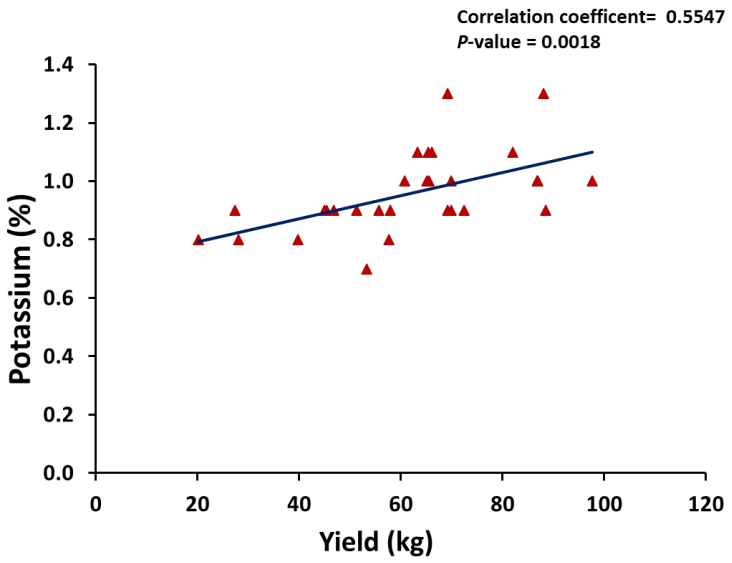
- Nutrient analysis
  - N, P, K, Ca, Mg, S, Mn, Zn, Cu, Fe, B

- Statistical analysis
  - Pearson Correlation, Alpha = 0.05

Correlation: Nutrient and Yield

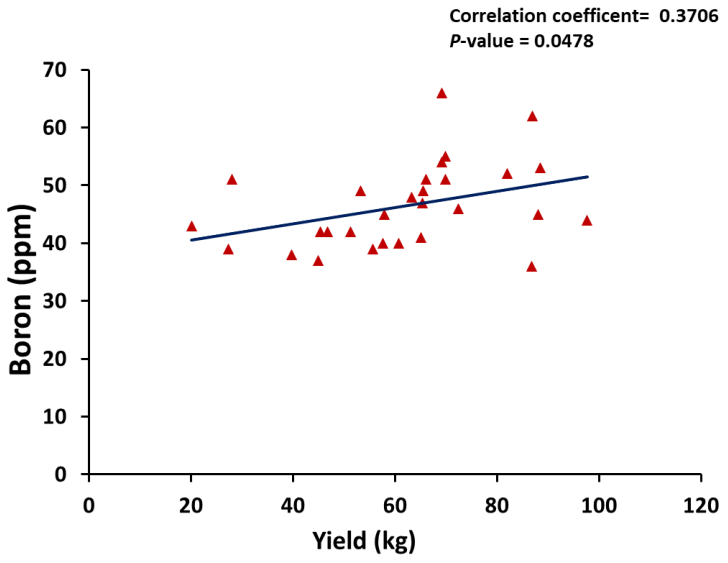
6-month spring flush (Aug)

Potassium



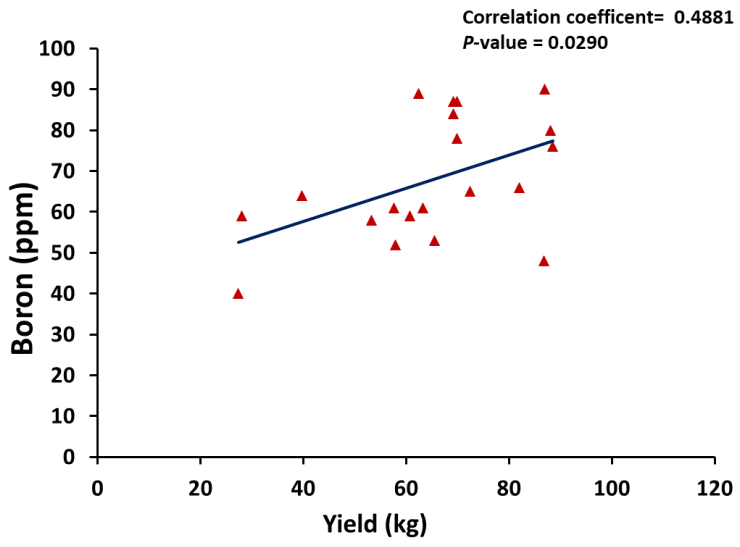
6-month spring flush (Aug)

Boron



9-month spring flush (Nov)

Boron



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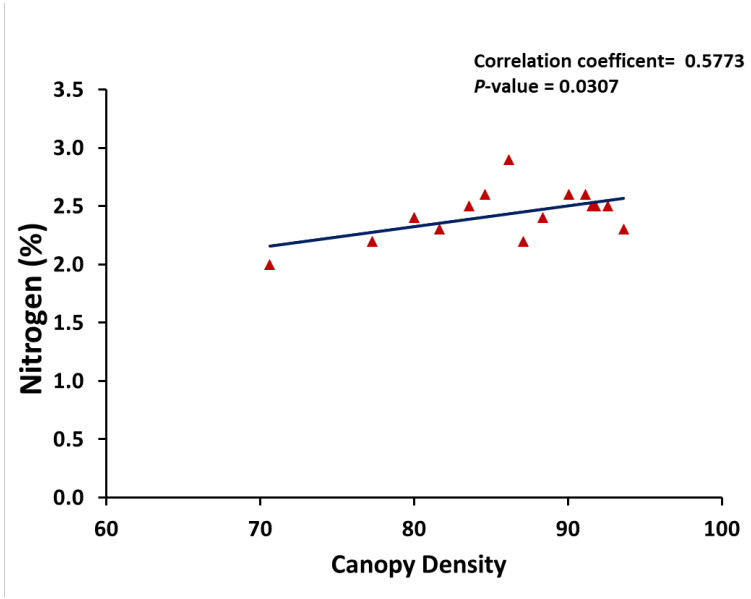
Correlation: Nutrient and Canopy Density

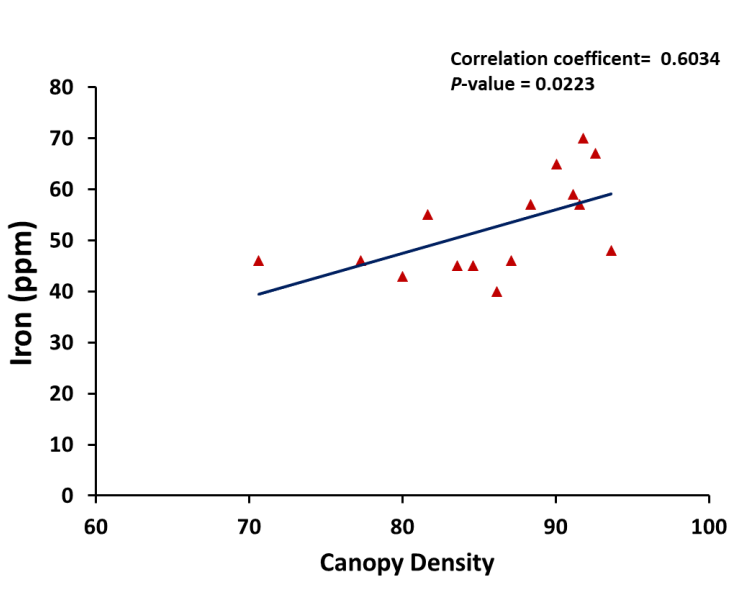
3-month spring flush (June)

Nitrogen



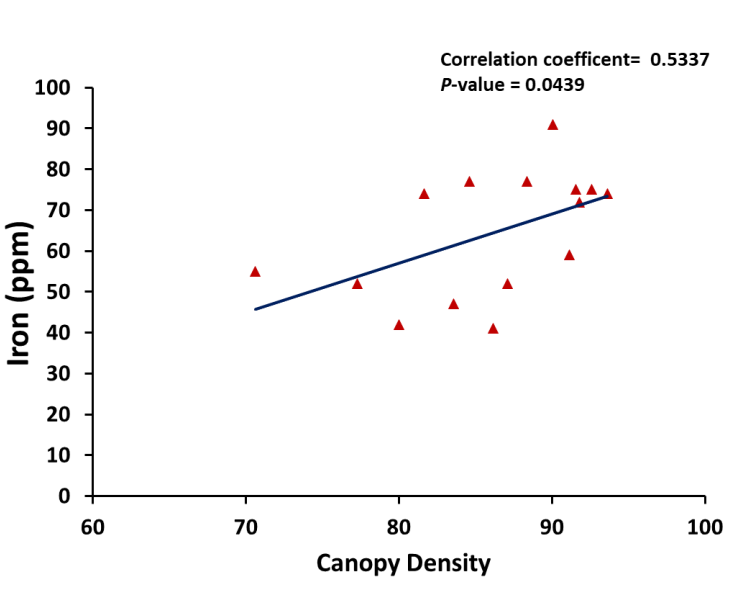
3-month spring flush (June)

Iron



9-month spring flush (Nov)

Iron



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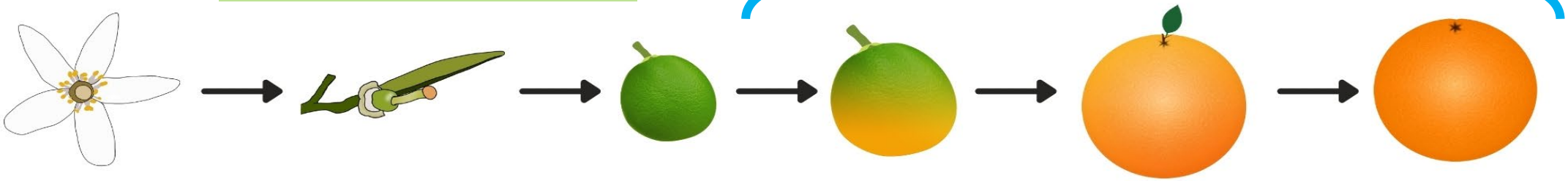
Tree Phenology and Nutrients

6–9-month spring flush:
Potassium and Boron

Fruit set



Flowering
Spring vegetative flush

Exponential fruit growth
Summer vegetative flush

Fruit maturation
Preharvest fruit drop

3-month spring flush: Nitrogen and Iron

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Summary

1. At least two leaf sampling (June and September) are needed to improve the canopy and fruit growth of HLB-affected trees
2. Spring leaf nutrient levels are correlated to canopy density and yield

A randomly collected leaf sample is comparable to spring flush in in June and September period.

Leaf age	Flush type	N	P	K	Ca	Mg	S	Mn	Zn	Cu	Fe	B
3-Month	Random	2.03	0.12	0.94	2.97	0.39	0.36	53.96	53.13	8.02	64.71	55.29
	Spring	2.34	0.14	1.32	2.48	0.40	0.33	29.60	37.20	9.13	50.63	39.23
6-Month	Random	2.47	0.13	1.14	2.42	0.39	0.31	82.47	101.37	9.10	56.27	57.83
	Spring	2.47	0.13	1.14	2.42	0.39	0.31	82.47	101.37	9.10	56.27	57.83
9-Month	Random	2.13	0.13	1.10	2.55	0.36	0.36	70.70	74.20	9.40	58.50	49.70
	Spring	2.22	0.14	1.11	2.53	0.38	0.34	81.93	81.77	10.77	67.87	65.93

Are we sampling the right leaf ?

Non fruiting leaf versus fruiting leaf?

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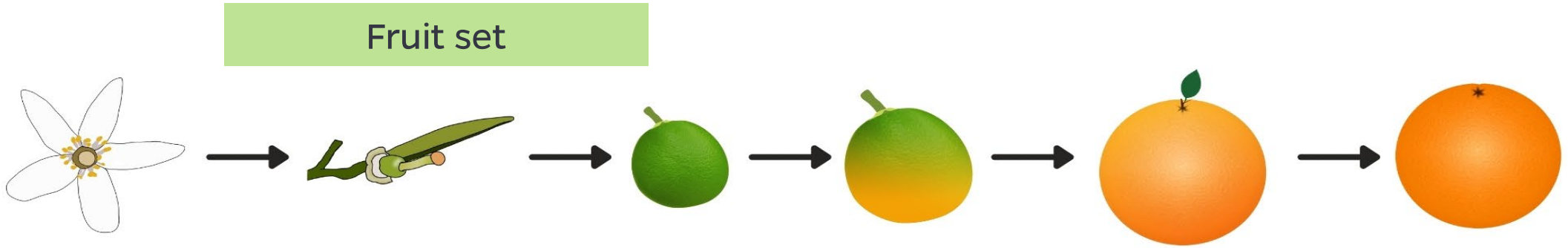
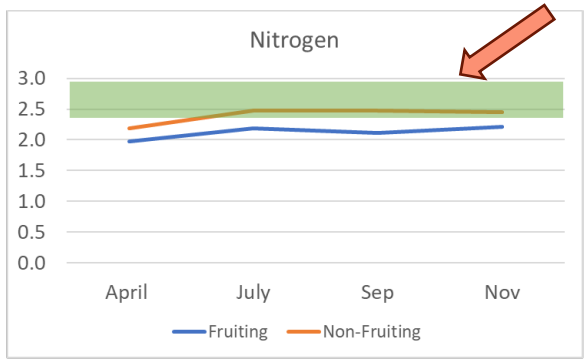
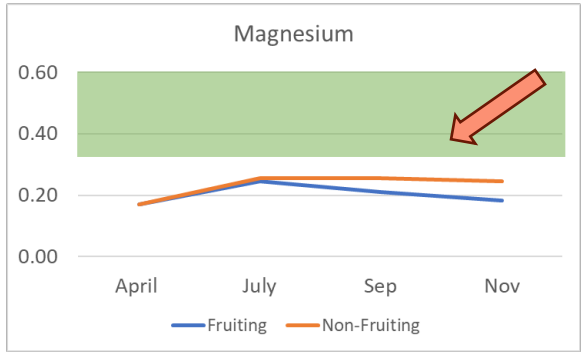
Fruit and new leaves compete for resources

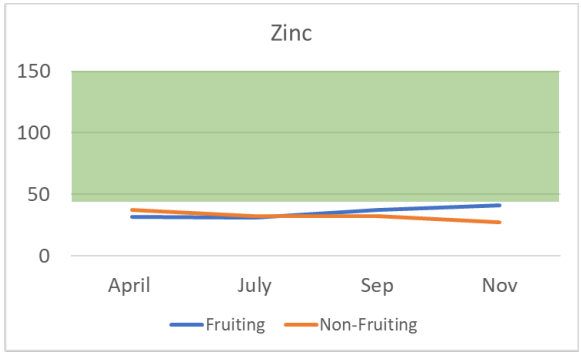


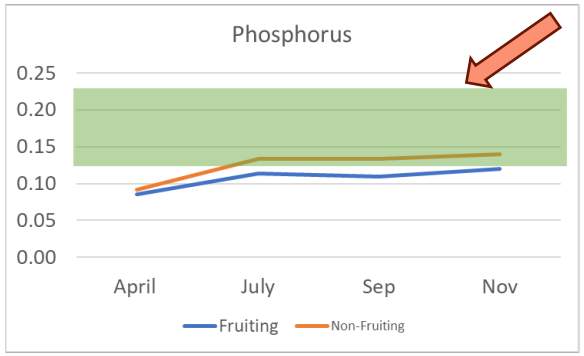
Fruit also need nutrients to continue growing!

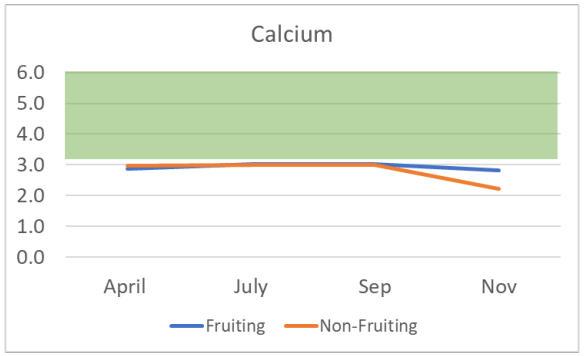
Fruiting and non-fruiting branches have different leaf nutrient profile

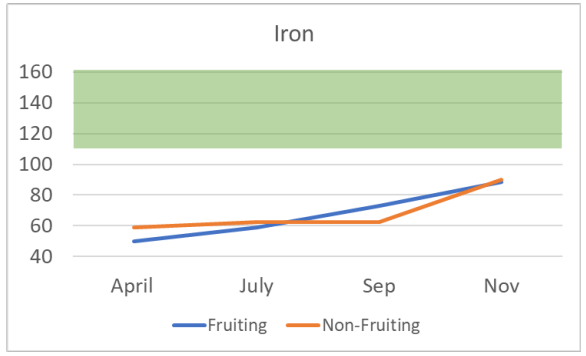


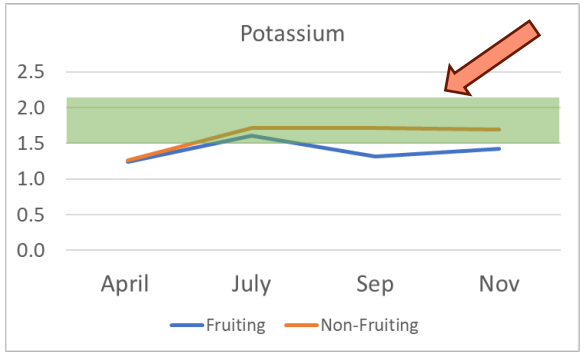


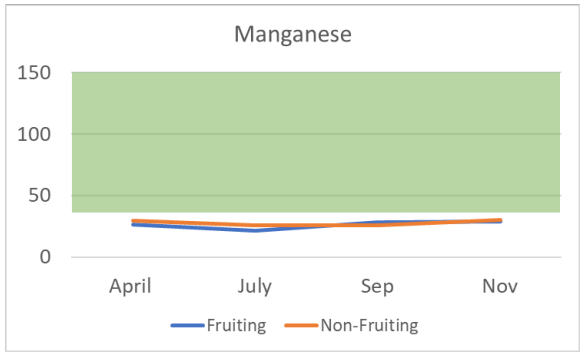


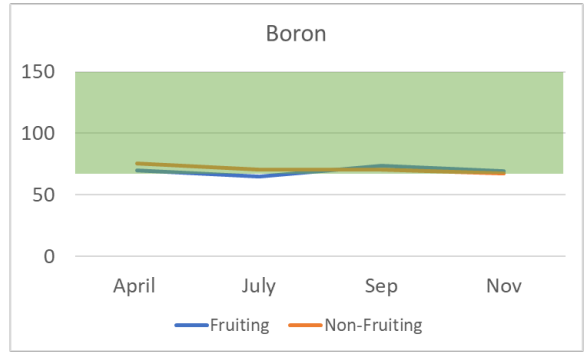












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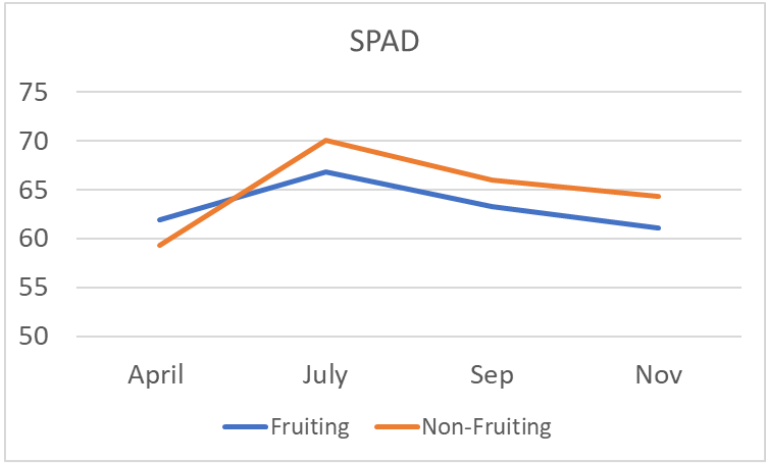
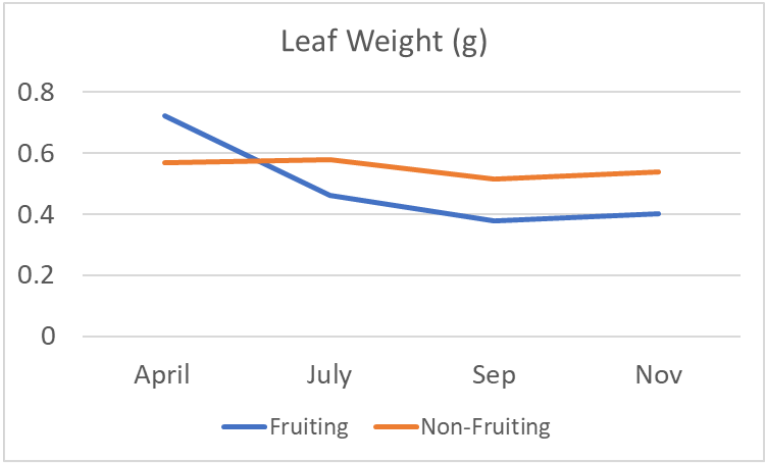
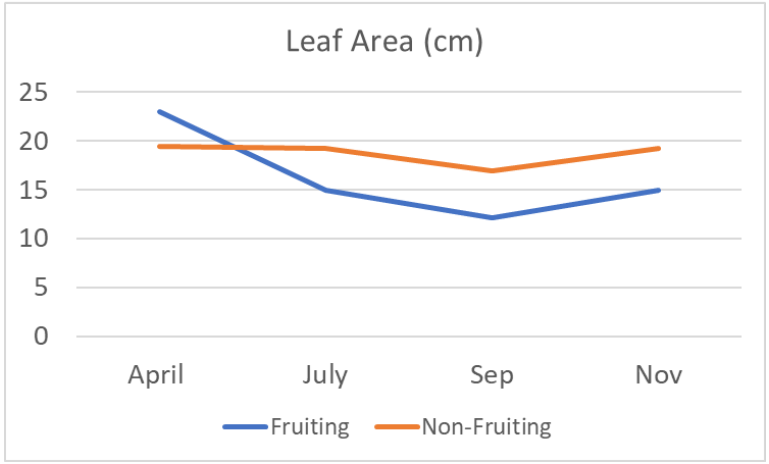
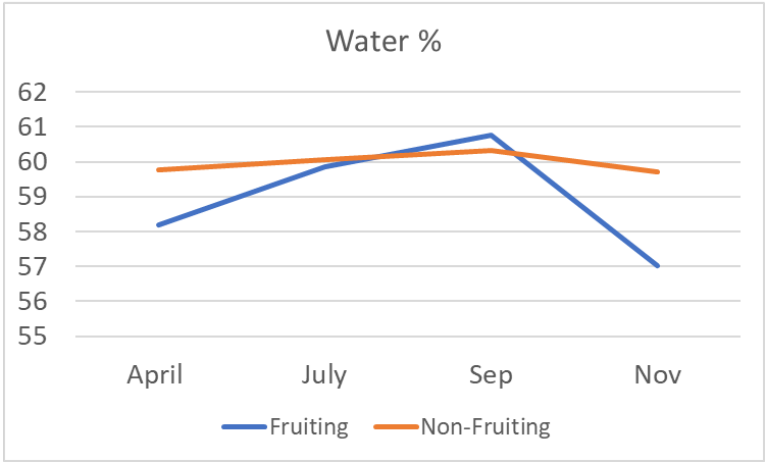
Some key characteristics are also subpar in fruiting leaves









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Do we need to fertilize based on fruiting branches?

- In many countries fruiting branches are sampled for leaf nutrient analysis
- Trial was initiated in 2024, 16-year-old Hamlin on Swingle
  - Leaf sample Feb 2, 2024
  - Fertilize March 1, 2024
  - Leaf sample April 3, 2024
  - Fertilize May 1, 2024
  - Leaf sample July 1, 2024
  - Fertilize August 1, 2024
  - Leaf sample September 5, 2024
  - Fertilize October 4, 2024
  - Leaf sample November 22, 2024
  - Harvest December 10th, 2024

Fertilization based on branch type improved canopy density within one year

	Canopy density	Yield (lbs/tree)	Yield efficiency	Canopy volume	Brix	Acid	Size
UTC	84.6 b	197	7.3	26	9.02	0.60	60.93
Fruiting	87.5 a	220	7.7	28	9.02	0.63	61.22
Non-fruiting	84.3 b	196	7.1	27	9.1	0.68	61.21

A promising trend of increase in yield is observed with fruiting branch-based fertilization

Growers can consider analyzing fruiting leaves before major summer fertilization to address what a growing fruit might be needing

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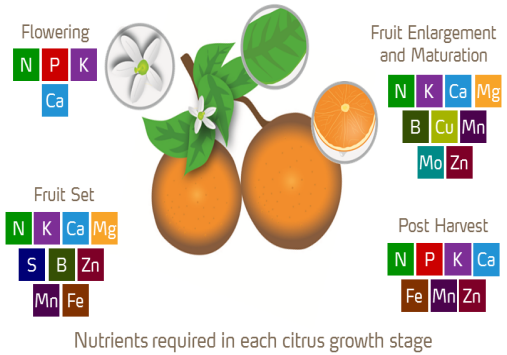
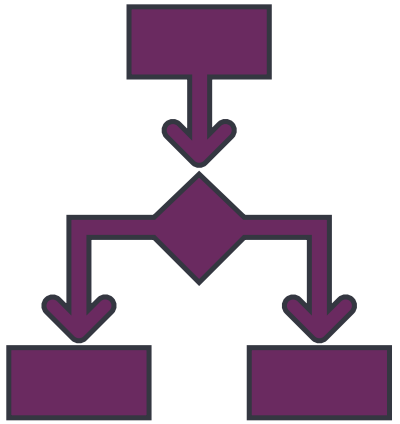
Summary – The Right Sample



Nutrients required in each citrus growth stage



Most accurate nutrient status of the tree spring flush

Adjust nutrient supply with tree phenology and fruit growth cycles

Frequent nutrient sampling, helps in fertilizer management decisions

Optimize fertilizer use, save money and increase yields

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Graphic: Images from Microsoft PowerPoint v. 2022

Take home message

1. Leaf nutrient analysis-based fertilization on can improve the yield of trees as well as improve canopy growth
2. At least two leaf sampling (June and September) are needed to improve the canopy and fruit growth of HLB-affected trees
3. Spring leaf nutrient levels are correlated to canopy density and yield
4. A random leaf sample can be collected as the results from spring leaves random leaves are comparable
5. Fruiting and non-fruiting leaves have very different nutrient profile. Preliminary evidence suggest that fertilizing based on fruiting leaves can be considered for improved productivity

Acknowledgements

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Any questions?

Thank you!

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