COMPLETE AND BALANCED NUTRITION PROGRAM FOR HLB-AFFECTED TREES

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- Goal
 - Effect of controlled release form of mineral nutrients, elevated levels of individual micronutrients, and soil pH amendments (to lower pH).
 - Soil applied
 - Constant supply of nutrients
 - Micronutrients at higher rate
 - Soil pH amendment



Soil-Applied Nutrition Program

- The plant uptakes nutrients when they are in a solution
- During the water uptake by the plant, the dissolved mineral nutrients get taken up by the plant and distributed throughout the canopy
- Mobile and immobile nutrients have equal and uniform distribution to all parts

of plant





Foliar Nutrition Program

- Thick leaf cuticle limits the nutrient uptake
- Significant amount of foliar spray washes away in soil:



- Pre HLB, trees had massive feeder root systems; therefore, could easily take up washed up nutrients
- HLB-affected trees have few feeder roots therefore, may not be effective in nutrient uptake
- With foliar sprays immobile nutrients can get locked in leaves

What are mobile nutrients?

- Will move to new growth areas
- Move in all direction
- These nutrient can be transported via xylem and phloem
- The deficiency symptoms will first show up in older leaves
- Nutrients: Nitrogen, Phosphorus, Potassium

Magnesium, Sulfur

• Soil-applied and foliar-applied both are adequate

What are immobile nutrients?

- Do not move in the plant
- Transported only via xylem
- Immobile nutrients will not move to new growth areas
- The deficiency symptoms will first show up in the new growth because they cannot take nutrients from the old leaves
- Nutrients: Calcium, Iron, Zinc, Copper,

Manganese, Boron, Molybdenum

- Soil-applied nutrients are adequate
- Should be supplied whenever there is growth



Soil pH

•At high soil pH most of the micronutrients

bind to the soil and becomes unavailable

•At extremely low soil pH most of the macro

and secondary nutrients become

unavailable

•The goal is to have right soil pH at the time

when nutrient uptake is expected

•We recommend to keep soil pH between

High pH

When you have extremely low pH, nutrients are not available for uptake

Low pH



5.5-6.5

HLB-affected trees decline more rapidly than healthy trees at high pH

рН	Disease	Total no. of Plants	Dead	Leaf Drop (%)
5.8	HLY	8	0	21
5.8	HLB	8	0	16
7	HLY	8	0	50
7	HLB	8	1	57
8	HLY	8	1	60
8	HLB	8	3	83

Day 60 pH 5.8 HLY vs HLB

HLY







Day 60 pH 7.0 HLY vs HLB

HLY





Day 60 pH 8.0 HLY vs HLB





Both HLB and HLY plants showed a tendency of bringing soil pH close to 7 in course of experiment



HLB-affected trees often have deficiency of nutrients

- Due to significant reduction in root mass
- Compromised physiological processes
- Bacterial infection may result in higher metabolism (plant defense response)



Micronutrient Field Trial

- Two locations: Fort Meade and Arcadia
- Valencia/Swingle; 10 to 15 year
- Completely Randomized Block Design
- Trial was initiated in February 2016 and will

end with 2019 harvest

- 45 trees per treatment
- All the fertilizer treatments are applied 3

times a year by hand in the wetted zone



Treatments

- 1. Conventional granular fertilizer + foliar
- 2. Conventional granular fertilizer + Tiger Micronutrient Mix
- 3. CRF + foliar
- 4. CRF + Tiger Micronutrient Mix
- 5. CRF + Tiger Micronutrient Mix + Tiger Mn elevated by 20%
- 6. CRF + Tiger Micronutrient Mix + Tiger Zn elevated by 20%

- 7. CRF + Tiger Micronutrient Mix + Tiger Fe elevated by 20%
- 8. CRF + Tiger Micronutrient Mix + Tiger B elevated by 20%
- 9. CRF + Tiger Micronutrient Mix + Tiger Mn and B elevated by 20%
- 10. CRF + Tiger Micronutrient Mix + Tiger Mn and B elevated by 50%

Rate of nutrients

- All the treatments received same amount of P, K, Ca, Mg
- Nitrogen: CNV: 180 lb/acre and CRF(Harrell's): 150 lb/acre
- Tiger Micronutrient mix (Mn-Zn-Fe-B:6-6-3-1); 1.5 pound per tree
- Mn: 12 lb/acre
- Zn: 12 lb/acre
- Fe: 6 lb/acre
- B: 2 lb/acre

20% elevated levels on Mn= 14.4 lb/acre 20% elevated levels on Zn= 14.4 lb/acre 20% elevated levels on Fe= 7.2 lb/acre 20% elevated levels on B= 2.4 lb/acre

Canopy Volume after 3 years of fertilization

Treatment #	Fort Meade	Arcadia
1 (Control)	26.8 b	30.6 b
2	29.6 ab	32.8 ab
3	34.3a	32.0 ab
4	28.0 ab	33.1 ab
5	29.8 ab	30.9 b
6	29.2 ab	30.1 b
7	25.2 ab	35.2 a
8	22.3 ab	35.1a
9	31.5 a	29.9 b
10	32.5 a	33.6 ab

Higher rates of Mn and B improved the leaf density of trees after two year of treatment





Large tree to tree variability!

No significant results at 95% confidence interval



However, at 90% confidence interval....





Yield- 2019 (Boxes per acre)



Fort Meade



Arcadia

3 Year Cumulative Yield(Boxes per acre)

Fort Meade

Arcadia





Ranking based on cumulative yield of 3 years

	Arcadia Site			Fort Meade Site	
Treatment #	Treatment	Total 3 Yr Yield (boxes per acre)	Treatment #	Treatment	Total 3 Yr Yield (boxes per acre)
7	CRF+Tiger MM + Fe 20%	1310	9	CRF+Tiger MM + Mn+B 20%	1130
4	CRF+Tiger MM	1263	4	CRF+Tiger MM	1076
8	CRF+Tiger MM +B 20%	1259	2	Conventional+ Tiger MM	1063
10	CRF+Tiger MM + Mn+ B 50%	1233	3	CRF+ foliar	1047
5	CRF+Tiger MM + Mn 20%	1136	5	CRF+Tiger MM + Mn 20%	1039
6	CRF+Tiger MM + Zn 20%	1118	10	CRF+Tiger MM + Mn+ B 50%	1034
2	Conventional+ Tiger MM	1095	6	CRF+Tiger MM + Zn 20%	1027
3	CRF+ foliar	1088	8	CRF+Tiger MM +B 20%	981
9	CRF+Tiger MM + Mn+B 20%	1048	7	CRF+Tiger MM + Fe 20%	913
1	Control	908	1	Control	893



Fort Meade



Arcadia





Fort Meade



Arcadia

<u>Sulfur</u>



	Fort Meade				Arcadia	
	2016	2018		2017	2018	
QRP + foliar	6.3	6.6	0.3	4.7	5.4	0.8
QRP+ Tiger MM	6.3	6.0	-0.3	4.9	5.4	0.5
CRF+ foliar	6.0	6.0	0	4.9	5.2	0.3
CRF+Tiger MM	6.2	6.2	0	4.7	5.0	0.3
CRF+Tiger MM + Mn 20%	6.2	6.1	-0.1	4.7	4.7	0.0
CRF+Tiger MM + Zn 20%	5.9	5.9	0	5.6	49	-0.7
CRF+Tiger MM + Fe 20%	6.2	6.2	0	5.0	5.0	-0.2
CRF+Tiger MM +B 20%	6.5	5.7	-0.8	1.0	J.0	0.1
CRF+Tiger MM + Mn+B 20%	6.2	5.9	-0.3	4.9	4.8	-0.1
CRF+Tiger MM + Mn+ B				5.2	4.8	-0.4
50%	6.3	6.2	-0.1	5.2	4.7	-0.5

Significant improvement in fruit size at Arcadia with added B and



Consumer Sensory Analysis



Dr. Yu Wang's Lab

Sample	Replicates	Comment	Brix	Acid	Ratio
Tı	R1 & R2	CNV+Foliar	9.4	0.88	10.68
Т6	R1 & R2	CRF+ TMM + Zn 20%	10.1	1.04	9.71
Т8	R1&R2	CRF+TMM+ B 20%	9.5	1.41	6.78
T9	R1 & R2	CRF+TMM + Mn 20%+B 20%	10.4	1.09	9.57
Tı	R ₃	CNV+Foliar	9.6	0.77	12.51
Т6	R ₃	CRF+ TMM + Zn 20%	8.7	1.11	7.84
Т8	R ₃	CRF+TMM+ B 20%	10.2	1.22	8.42
Тэ	R ₃	CRF+TMM + Mn 20%+B 20%	10.3	0.86	11.97



Take Home Message

- Soil applied fertilizer program is beneficial for HLB-affected trees
- With CRF, the rate of N applied was reduced to150 lb/acre as well as other nutrients
- 20-50% higher rates of micronutrient improved the tree yield
- Use of CRF with sulphur bentonite fertilizer seems promising
- Nutrition does have an effect on fruit quality!
- Focus should be on constant supply of nutrients, all nutrients
 - Either frequent application of conventional fertilizer
 - Adding some amount of CRF
 - Uninterrupted fertigation

Thank you

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