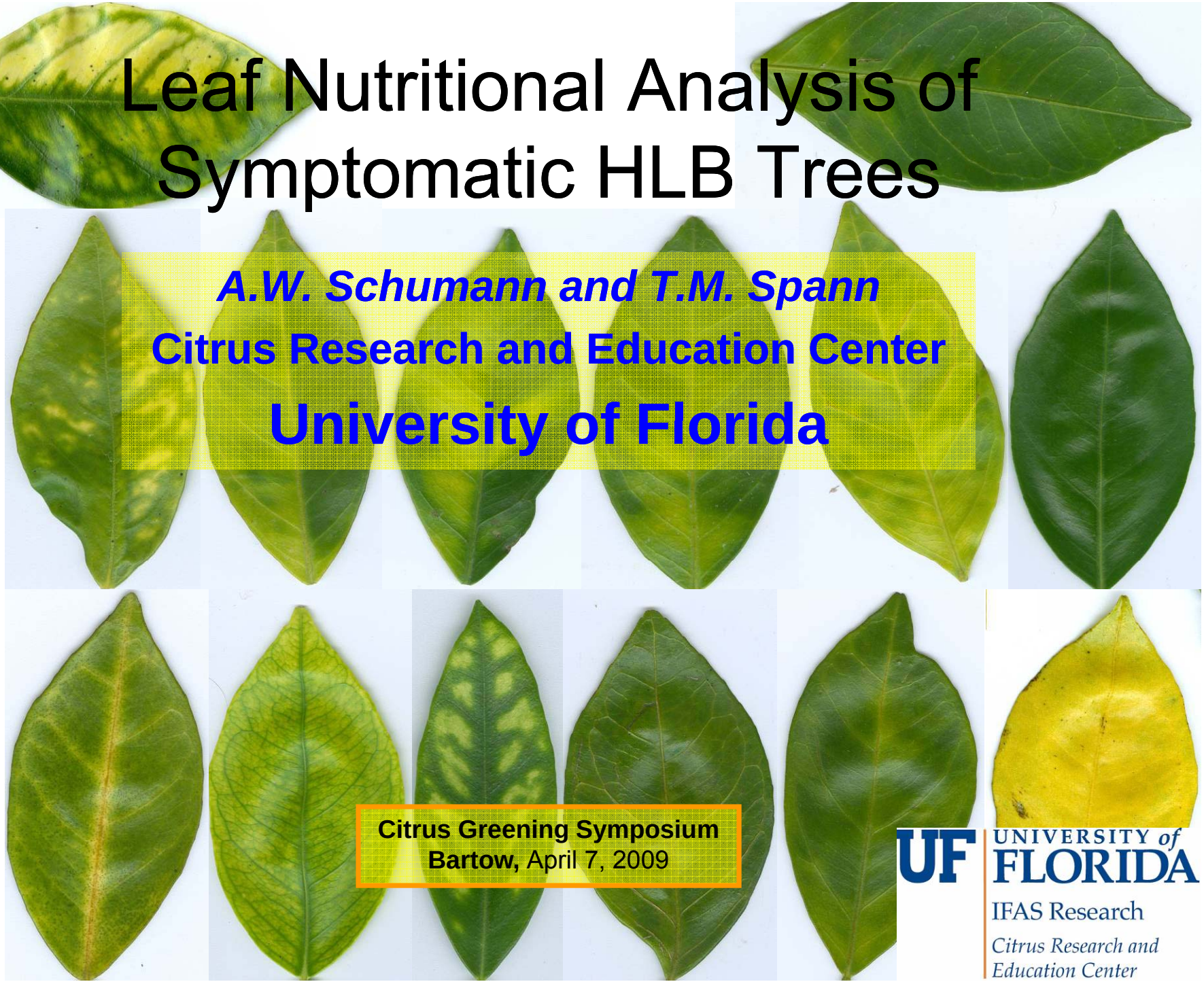
Leaf Nutritional Analysis of Symptomatic HLB Trees



A.W. Schumann and T.M. Spann

Citrus Research and Education Center

University of Florida

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Why are we interested in studying plant nutrients in HLB-infected trees?

- Abundant evidence exists in the literature that plant resistance to disease is affected by nutrients. Can we exploit this?

- By discovering how nutrients and HLB interact, we can better understand the disease and its impact on trees.
- Nutrient imbalances induced by HLB may provide chemical signatures of the disease for early detection purposes.
- Do HLB-associated nutrient deficiencies limit tree growth and yield as do “real” deficiencies?
- If so, can remedial applications of nutrients mitigate the severity of HLB in trees and prolong their fruit production?

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Does tree decline from HLB resemble grove abandonment?

- **Grove decline from complete abandonment (no fertilizer, irrigation, pesticide spray) is rapid (2-3 years).**
- **(nutrient deficiencies can weaken and kill trees!)**
- **The severe nutrient deficiencies observed in advanced stages of HLB infection may contribute to tree decline.**
- **Can fertilizer help?**

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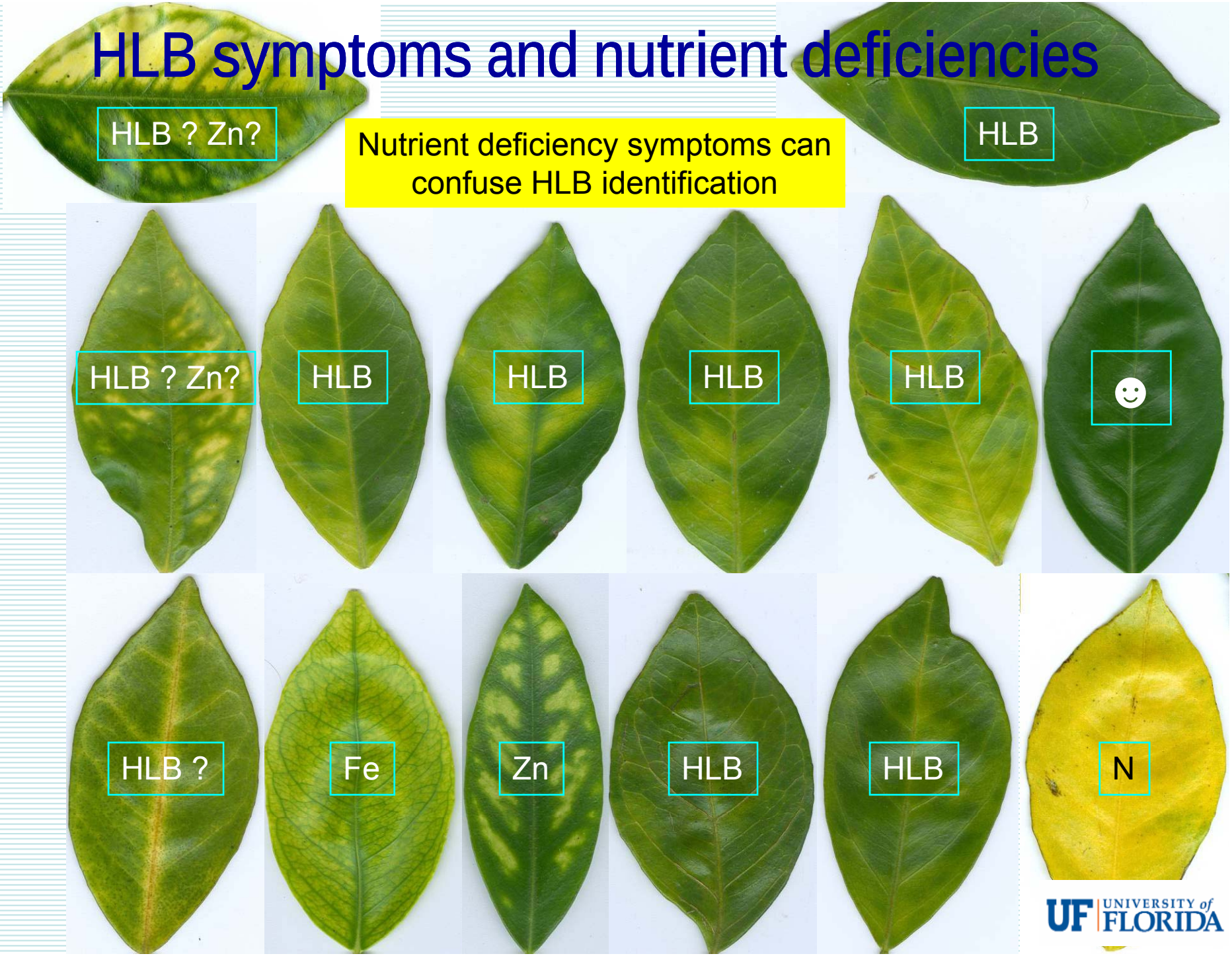
HLB symptoms and nutrient deficiencies



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“Rabbit ears” – “Zn deficiency”

“Rabbit ears/ yellow shoot” – “Zn deficiency”

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Blotchy mottle + “yellow vein”, “corky vein” or thickened leaf– HLB or “B deficiency”

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How do nutrients interact with plant diseases?

- If pathogens are able to penetrate or live in the vascular system of the plant, a common symptom is a lower nutrient concentration in the shoot, which leads to deficiency.

- If the pathogen directly or indirectly harms the root system, the resulting lower nutrient uptake may appear as a nutrient deficiency in the shoot.

- Drastic imbalances of shoot chemistry caused by disease (e.g. nutrients, starch, sugars) may alter the measured concentrations of nutrients by dilution or concentration effects ("false deficiencies").

- HLB: carbohydrate mobilization disrupted –> starch accumulation in the leaves –> nutrient concentrations change.

The effect of starch accumulation on nutrients

- **Nutrient concentrations in leaves are traditionally expressed on a dry weight basis (%, or ppm).**

- **What happens if the dry weight is increased by starch accumulation during HLB infection in blotchy mottled leaves? (can be up to 50% more dry weight in a leaf).**

- **The starch dilutes the nutrient concentration, although the total amount in the leaf tissue remains the same.**

- **Thus "false deficiencies" are common when diagnosing HLB-infected leaves using nutrient concentrations.**

- **The alternative? Express nutrients on leaf area basis or analyze the nutrient balance using the Diagnosis and Recommendation Integrated System (DRIS)**

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How does DRIS help analyze HLB leaves?

- **DRIS cancels out the dry weight (DW denominator) in the nutrient concentrations by analyzing them as a series of ratios.**
- **e.g. N/P, P/K, K/Mg etc**
- **So, N/P is actually (g N / g DW) / (g P / g DW) = g N / g P**
- **DRIS was designed to analyze nutrient balance and factor out external influences like seasons, leaf age, drought and other stresses (like disease).**

Citrus leaf nutrients – untreated trees (80)

Nutrient	Symptomatic	Asymptomatic	'Normal'
N %	1.97*	2.67	2.9
P %	0.14*	0.16	0.16
K %	1.35	1.29	1.18
Ca %	3.08*	4.92	3.87
Mg %	0.24*	0.34	0.47
S %	0.26*	0.36	0.32
Fe ppm	67*	94	102
Mn ppm	19	18	35
Zn ppm	16	16	32
Cu ppm	61	64	12
B ppm	35*	49	75

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Citrus leaf nutrients – sprayed trees (20)

Nutrient	HLB+ Symptomatic	HLB+ Asymptomatic	Healthy Asymptomatic	Analysis by DRIS or by leaf area
N %	2.48*	2.84	2.7	NS, NS
P %	0.15	0.15	0.14	NS, ***
K %	1.08*	0.81	0.94	**, ***
Ca %	2.84*	4.09	4.32	***, ***
Mg %	0.29*	0.34	0.41	***, ***
S %	0.26*	0.31	0.30	NS, NS
Fe ppm	51	53	56	NS, NS
Mn ppm	107	86	83	*, *
Zn ppm	45	36	32	NS, NS
Cu ppm	9	9	9	NS, NS
B ppm	48*	54	76	***, ***

Symptoms of severe B deficiency also observed in HLB-infected trees

Boron and Zinc

The roles of Zn and B are critical in flowering and fruit set:

- **Boron is essential for fruit set and pollen tube growth and longevity of the flower ovule. Aim for 36-100 ppm in leaf samples. Some research shows foliar B is not readily transported to the roots. Soil-applied B at 1/300 N rate may be best long-term remedy. BEWARE:– TOXICITY LEVELS ARE EASILY EXCEEDED**

- **Zinc deficiency lowers yield, reduces tree vigor, leaf size, and makes fruit small and poor in quality. Zn is critical for enzyme systems and is best applied as foliar spray. Best results are obtained by spraying when the spring flush leaves are one-third to two-thirds developed.**

Conclusions / Summary

- **Evidence of abnormal concentrations of N,P,K,Ca,Mg,S,Fe,Mn,Zn,Cu,B in HLB-symptomatic leaves.**

- **Using DRIS or leaf area corrections, Ca, Mg, Mn, B were identified as likely "real" deficiencies, while K was consistently higher in HLB symptomatic leaves.**

- **B concentrations were lower in both symptomatic and asymptomatic leaves of HLB-infected trees -> a possible early indicator of the disease.**

- **THESE ARE PRELIMINARY RESULTS**

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Conclusions / Summary

- **Micronutrient deficiency symptoms are common in HLB trees (secondary symptoms).**

- **Some nutrient deficiencies in HLB trees are real; others are induced by changes in dry weight (starch).**

- **Keep up a good micronutrient spray program to minimize nutrient deficiency symptoms and therefore improve visibility of HLB symptoms. Include B in sprays or granular fertilizer.**

- **Possible mitigating effects of nutrients on HLB trees are being studied by IFAS scientists.**

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