The most critical step to a good nutrition program

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Leaf nutrient analysis is an important part of a successful citrus management program. Good fertilization practices are critical for optimal crop production, especially in HLB conditions. The two main objectives of nutrition management in citrus are 1) optimum and consistent yield and 2) building a strong tree that grows and produces year after year. Therefore, a nutrition program needs to be carefully managed and assessed to ensure both objectives are met.

Citrus trees perform best when their leaves are kept in the optimum range of each nutrient. Nutrient deficiencies or excesses can result in poor tree growth and low yield. For example, maximum yield can be achieved at 2.5% to 2.7% nitrogen concentrations in 4- to 6-month-old spring growth of healthy orange trees. Any variation above or below this optimum range can result in decreased yield.

In the last decade, several scientific reports have demonstrated that good fertilization improves the health and productivity of HLB-affected trees. However, conflicting reports about the non-conclusive effects of fertilizer on HLB-affected trees has led to confusion. In a Citrus Research and Development Foundation-funded trial (15-0013), the same fertilizer treatments were applied at two sites (Arcadia and Fort Meade) on mature Valencia grafted on Swingle trees of similar age. After five years of the experiment, it was concluded that the use of a constant supply of nutrients along with a 20% higher rate of micronutrients can significantly improve the yield compared to standard fertilization practices.

However, the best-performing treatments are not the same at the two sites. The best performer at one site was the worst performer at the other site and vice versa. These findings suggest that a fertilizer program cannot be adopted without site-specific adjustments. Multiple factors (such as soil profile, tree nutrient level, tree health, HLB status, etc.) play a critical role in the success of a nutrition program. Each site is unique, and a fertilizer program should address the specific needs of the site and grove. Therefore, regular leaf sampling to identify tree nutrient status and

Table 1. Leaf nutrient concentrations from fruiting and non-fruiting branches of HLB-affected Hamlin and Valencia trees

Nutrients	Branch	Hamlin				Valencia			
		Aug 2021	Dec 2021	Feb 2022	May 2022	Aug 2021	Dec 2021	Feb 2022	May 2022
N (%)	Fruiting	2.46	1.98 b	2.06 b	2.20 b	2.22	1.82 b	2.08	2.0 b
	Non-Fruiting	2.52	2.18 a	2.40 a	2.62 a	2.38	2.18 a	2.14	2.4 a
P (%)	Fruiting	0.13	0.12 b	0.10 b	0.11 b	0.11 b	0.14 b	0.13	0.11 b
	Non-Fruiting	0.14	0.16 a	0.13 a	0.14 a	0.13 a	0.17 a	0.14	0.14 a
K (%)	Fruiting	0.88 b	0.96 b	1.16 b	1.42	0.86 b	0.96 b	0.94 b	1.18
	Non-Fruiting	1.22 a	1.56 a	1.62 a	1.68	1.30 a	1.48 a	1.34 a	1.38
Ca (%)	Fruiting	3.40	3.24 a	2.88	3.12	3.78	4.26 a	3.38 a	3.04
	Non-Fruiting	3.22	2.48 b	2.64	2.88	3.34	2.76 b	2.50 b	3.04
Mg (%)	Fruiting	0.49	0.35	0.36	0.48	0.44	0.41 a	0.34	0.38
	Non-Fruiting	0.44	0.38	0.35	0.47	0.36	0.37 b	0.32	0.40
S (%)	Fruiting	0.40	0.37	0.49	0.51	0.41	0.42	0.36	0.36
	Non-Fruiting	0.40	0.40	0.56	0.48	0.41	0.38	0.37	0.39

Different letters after the numbers indicate statistically significant differences between fruiting and non-fruiting branches at each time point.

requirements should be part of managing a fertilizer program.

Collecting the correct leaf sample is the first step in making fertilizer decisions. Random leaf collections around the tree canopy can lead to unreliable outcomes. Thus, using a standard practice for leaf sampling (e.g., leaf samples taken either from fruiting or non-fruiting branches) is important for determining the baseline of tree nutrition requirements. Correct leaf sampling can influence diagnosis and treatment.

The recommendation in Florida is to sample 4- to 6-month-old spring leaves from non-fruiting branches. However, non-fruiting branches do not always receive much attention. When the fruit is green, a very careful assessment of the branch is required. To understand whether it is critical to sample non-fruiting branches for nutrient analysis, researchers took leaf samples from either fruiting or non-fruiting branches over a year to monitor variations in nutrient concentrations (accounting for seasonal variation).

STUDY SETUP

Ten-year-old Hamlin and Valencia trees with mild HLB symptoms were grown in Central Florida orchards and used during the 2021–22 production season. Thirty leaves were collected from fruiting (three to four leaves behind the fruit) and non-fruiting branches at four times (August 2021, December 2021, February 2022 and May 2022). The ground leaf samples were sent to Central Florida Soil Laboratory in Bartow after washing and drying. Standard nutrient analyses for macronutrients and micronutrients were performed.

RESEARCH RESULTS

Primary Macronutrients

Hamlin and Valencia showed a similar pattern (accumulation or depletion) for leaf nutrient concentrations over time, but there were significant differences between fruiting and non-fruiting leaves. Nitrogen (N), phosphorus (P) and potassium (K) concentrations were higher in fruiting than non-fruiting leaves (see Table 1, page 14). Minor differences in nutrient concentrations were found at a few time points that may coincide

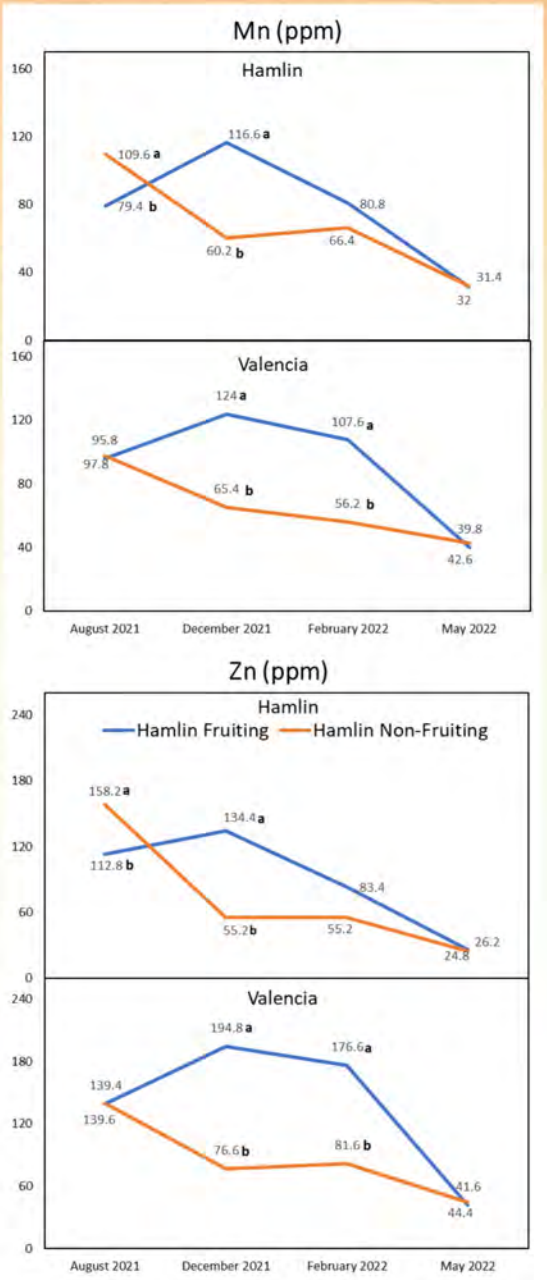

Figure 1. Manganese (Mn) and zinc (Zn) concentrations in fruiting and non-fruiting leaves of HLB-affected Hamlin and Valencia trees

with the different fruiting habits of Hamlin and Valencia.

N and K directly influence fruit development and quality. Lower concentrations of these nutrients in fruiting leaves could be linked with their rapid utilization. Interestingly, HLB-affected leaves exhibited the same pattern of nutrient (N, P, K) concentrations as documented in healthy trees (Embleton et al., 1963).

Secondary Macronutrients

In December 2021, Hamlin and Valencia had a higher calcium (Ca) concentration in fruiting compared to non-fruiting leaves (see Table 1). Magnesium (Mg) concentrations in Valencia were higher in fruiting leaves compared to non-fruiting leaves in December 2021. No such differences were found in Hamlin. Sulfur (S) concentrations were the same between fruiting and non-fruiting leaves. This trend is similar to healthy trees as documented by Embleton et al.

Micronutrients

Overall, micronutrient concentrations in both Hamlin and Valencia exhibited a decreasing trend over time, apart from copper (Cu), which increased over time. In August 2021, manganese (Mn) and zinc

(Zn) concentrations were higher in non-fruiting leaves compared to fruiting leaves. Then, in December 2022 and February 2022, their concentrations in non-fruiting leaves decreased below their concentrations in fruiting leaves (see Figure 1, page 16). Mn and Zn exhibited a similar pattern for both fruiting and non-fruiting leaves in Hamlin and Valencia. In general, fruiting leaves had higher Mn and Zn concentrations than non-fruiting leaves.

Altogether, the decreases in micronutrient concentrations in both fruiting and non-fruiting leaves indicate the use of these nutrients for defense and growth. Therefore, higher than the recommended rates (20%) of micronutrients are beneficial in HLB conditions.

SUMMARY

In summary, Hamlin and Valencia showed a similar pattern for nutrient concentrations in fruiting and non-fruiting leaves. Macronutrients (N, P, K) and micronutrients (Mn, Zn) were higher and lower, respectively, in non-fruiting leaves compared with fruiting leaves. This trend is similar to healthy trees as documented in 1963 by Embleton et al.

The Ca concentration decreased in both fruiting and non-fruiting leaves of HLB-affected trees when compared to the healthy ones. Therefore, it can be concluded that enhanced Ca fertilization is required for HLB-affected trees. In addition, this study also suggests that growers need to pay more attention to micronutrients going into fall when fruit drop increases. It is possible that fruit drop is linked to a decrease in micronutrients in fall.

Lastly, this study also highlights the importance of using the correct leaf samples for getting the most accurate leaf nutrient analysis. Consistency is key. Consistent non-fruiting leaf sampling will help citrus growers design a nutrition program better suited for the current nutritional needs of their trees under HLB conditions.

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