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Impact of high-density planting and enhanced nutrition on HLB-affected grapefruit

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Florida citrus growers have been using high-density planting and different soil and foliar fertilizer application strategies to compensate for the adverse effects of huanglongbing (HLB). Recent studies indicate that high-density plantings and enhanced nutritional programs with higher micronutrient levels, such as the application of controlled-release fertilizer, could mitigate disease symptoms and extend the life span of sweet orange trees. Studies are limited to tree density, and there is little literature available about the effect of high-density plantings and soil and foliar nutrient application on HLB-affected grapefruit tree health, fruit yield and fruit quality.

A large-scale field trial was conducted from 2018 to 2020 at the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) Indian River Research and Education Center (IRREC) in Fort Pierce. The study evaluated tree-planting density, soil micronutrient application and foliar-applied micronutrients on grapefruit tree growth and fruit yield parameters, physiological response and HLB incidence. The results were recently published in HortScience (see journals.ashs.org/hortsci/view/journals/hortsci/55/9/article-p1411.xml and journals.ashs.org/hortsci/view/journals/hortsci/55/9/article-p1420.xml).

TREATMENTS TESTED

The study tested the effect of a combination of factors and treatments as follows:

1) Three planting densities:
   - Single-row low density (SR/LD), 119 trees per acre
   - Single-row high density (SR/HD), 173 trees per acre
   - Double-row high density (DR/HD), 393 trees per acre
2) Two controlled-release fertilizer (CRF) blends:

- CRF1: 12N-1.31P-11.62K and micronutrients at 1x the UF/IFAS recommendation with micronutrients as sulfates
- CRF2: Enhanced 12N-1.31P-11.62K with 2x magnesium and 2.5x the UF/IFAS recommendation with micronutrients as sulfur-coated products

3) Foliar micronutrient application (a blend of boron, manganese and zinc) at 0x, 1.5x, 3x and 6x UF/IFAS recommended rates from Nutrition of Florida Citrus Trees, 3rd Edition (edis.ifas.ufl.edu/publication/ss478).

The soil-applied blends were formulated to meet the UF/IFAS annual recommendation for grapefruit in Florida at 160 pounds of nitrogen per acre. The treatments focus on using enhanced soil and foliar nutrients to manage HLB-affected trees by sustaining production and mitigating citrus decline.

The study was conducted using HLB-affected 7-year-old Ray Ruby grapefruit on Kuharske citrange arranged in a split-split-plot design with four replications. A total of 96 experimental units measuring 50 by 95 feet were used. Each unit was in a bedded grove of 400 by 570 feet (~5.3 acres).

Tree size (canopy height, trunk diameter and canopy volume) was measured twice per year. Fruit yield, size categories and fruit quality (total soluble solids and acidity) were measured after harvest. Leaf gas exchange responses (photosynthesis and stomatal conductance) were measured in the spring with a portable infrared gas analyzer. HLB symptoms and incidence and bacterial titer were confirmed against *Candidatus* Liberibacter asiaticus. Soil and leaf sampling were collected from all the plots to see nutrient concentration. Soil moisture sensors were installed in the field at 48 different locations to monitor the soil moisture content.

RESEARCH RESULTS

High-density planting decreased tree growth due to competition for water, fertilizer and solar radiation (Figure 1, page 16) but increased fruit yield (Figure 2, page 16). However, the number of fruits per tree was reduced.

Figure 1. Side-by-side comparison of Ray Ruby grapefruit trees on Kuharske rootstock subjected to different plant densities and foliar and soil nutritional treatments.

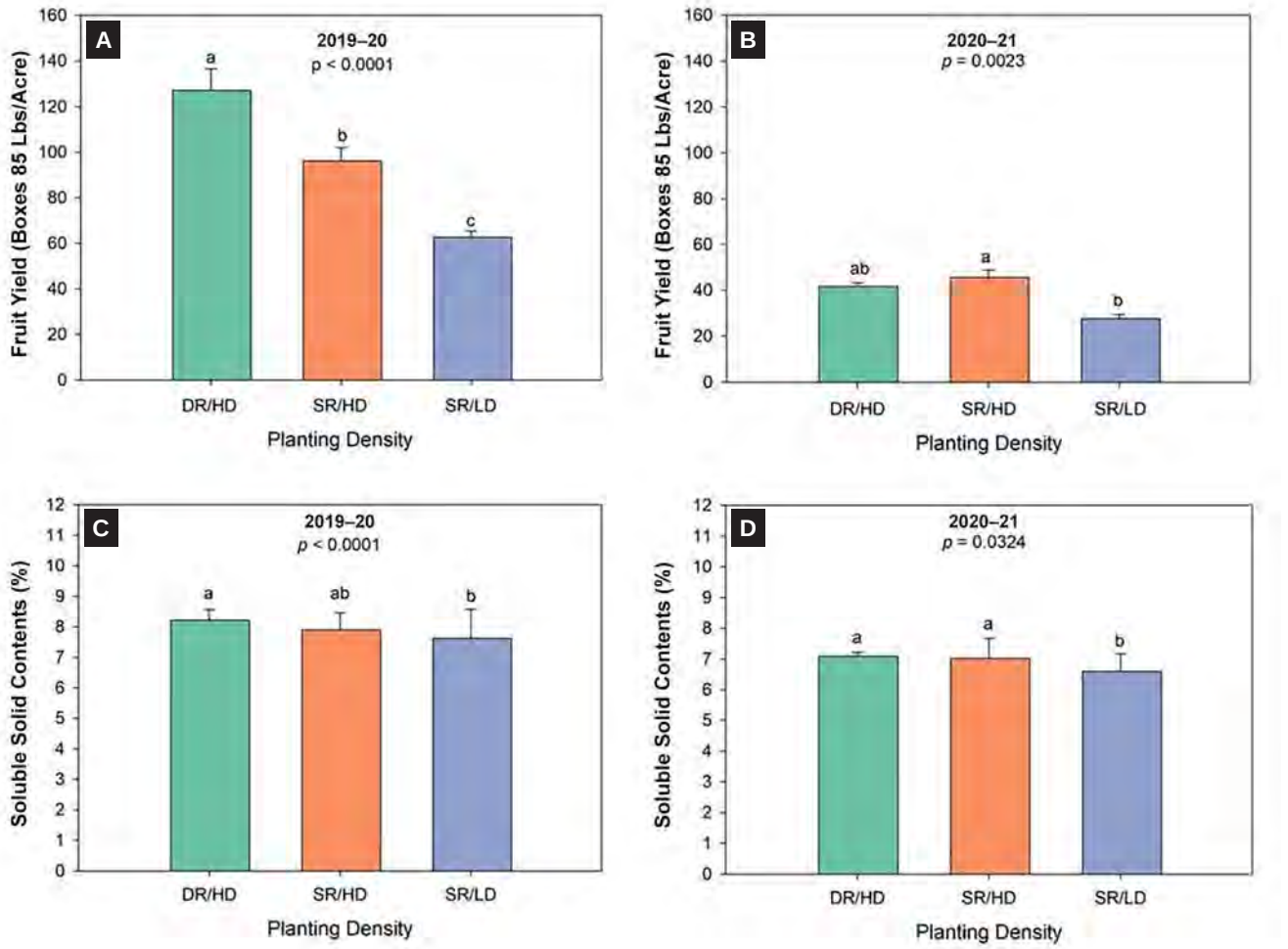

Figure 2. Effect of planting density on fruit yield in 2019-20 (A) and 2020-21 (B) and on soluble solids content in 2019-20 (C) and 2020-21 (D)

High-density planting increased total soluble solids (Figure 2, page 16) but decreased leaf photosynthesis and stomatal conductance due to shading from small tree spacing.

Applying soil and foliar nutrients at a higher micronutrient application improved the tree canopy size and health with dense dark green leaves, as illustrated in Figure 1 (page 16). Soil application of enhanced micronutrients increased plant photosynthesis. Soil and foliar application of enhanced micronutrients did not affect fruit yield soluble contents, but foliar application increased the fruit acidity. Past studies indicate that HLB-affected trees had a lower concentration of micronutrients and macronutrients in their leaves than healthy trees. A general trend was that improved soil and foliar micronutrient soil indicated higher leaf micronutrient concentrations than CRF at the current UF/IFAS recommendation.

In conclusion, high-density planting improved tree growth, fruit yield and fruit quality. Fertilizer blends applied in the soil did not change the disease incidence but resulted in higher canopy volume without affecting fruit production or quality. Foliar application of micronutrients did not affect HLB incidence, tree growth or fruit quality. However, fruit yield and photosynthesis decreased as foliar-applied micronutrients increased. The two-year study showed that, while excessive supplemental nutrient application is not beneficial for grapefruit trees affected by HLB, high-density planting appears to be a good strategy for grapefruit production under HLB-endemic conditions.

Soil application of enhanced micronutrients increased plant photosynthesis.

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