

# Effects of HLB infection on sweet orange fruit size and quality

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The visible symptoms of Huanglongbing (HLB, citrus greening) infection are very well documented – blotchy mottle on leaves, vein corking, small misshapen fruit, premature fruit drop, fruit with low sugar and high acid – but there is little information available that provides details about how yield and juice quality change in infected trees.

Over the past two seasons, we have been harvesting HLB symptomatic and apparently healthy asymptomatic trees from groves around the state to understand the specific impacts HLB infection has on fruit size, fruit number, total yield and juice quality. The results of these studies are discussed in this article.

During the 2008-09 and 2009-10 harvest seasons, we harvested Hamlin and Valencia fruit. The groves were located in Felda, Lorida and Arcadia. The Lorida and Arcadia groves were

harvested only during the 2008-09 season, whereas the Felda grove was harvested in both seasons. In each grove we selected 20 trees to harvest – 10 trees with visible HLB symptoms and 10 free of HLB symptoms. The same 20 trees were sampled in each grove both years. None of the healthy appearing trees ever tested positive for HLB by PCR analysis. On the other hand, some of the HLB symptomatic trees were PCR positive, so we are confident that all HLB trees were infected based on the presence of “classic” symptoms.

All fruit from all study trees were run on a sizing/grading line to determine individual fruit diameter and weight. We compiled graphs of fruit size and weight distributions for HLB and healthy trees. From each tree two composite fruit samples — “normal” average size fruit or small fruit — were used for juice quality analysis. In the case of HLB-infected trees, the small fruit sample was composed almost entirely of symptomatic fruit,

whereas on the healthy trees, this sample was merely composed of apparently healthy fruit that happened to be small. The samples were juiced by hand and complete quality characteristics were assessed. By sampling small and average-size fruit from both healthy and HLB trees, we were able to distinguish true HLB quality changes from those which may simply be an artifact of fruit size.

Although the visible percentage of each tree canopy that showed HLB symptoms was somewhat variable (<10 percent to >50 percent), the parameters we measured were still significantly different between healthy and HLB infected trees. The pictures in Figure 1, page 15, show a typical fruit size distribution for healthy and HLB infected trees. The number of fruit in the smallest size classes (<60-63 mm or 2.25-2.5 inches) is significantly greater for HLB-infected trees compared with healthy trees. This indicates that the average fruit size per tree is smaller on HLB infected trees compared to



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**Figure 1.** Pictures showing the distribution of fruit (smallest to largest, left to right) after grading on a commercial sizing line. The top row of bins shows fruit from a healthy tree and the bottom row shows fruit from an HLB-infected tree. Note the large difference in the number of smallest fruit (in the left bin) between healthy and HLB trees.



healthy trees. Although this trend was present for both Hamlin and Valencia trees, the magnitude of the shift in fruit size appears to be greater for Hamlin than Valencia.

There was approximately a one-box decrease in total yield (weight) per tree as a result of HLB infection across groves and varieties in 2008-09. During the 2009-10 season, the decrease was almost two boxes for Hamlin, but there was no difference for Valencia. However, 2009-10 yields for both varieties were low regardless of tree health. It is likely that a late frost during bloom in 2009 affected the 2009-10 yield, making it difficult to sort out the HLB effects from environmental effects.

Fruit quality changes were generally only detectable in the small (symptomatic) fruit from HLB infected trees. The juice quality analysis for Hamlin fruit harvested in Florida during the 2008-09 season (See table 1, page 16) is typical of the results from the other groves and years and are used here as an example. The small (symptomatic) fruit usually have lower Brix and high acid, resulting in low ratio juice. Juice color is sometimes, but not always, poorer in these fruit. Juice yield per fruit is also less for symptomatic fruit, but this appears to be related to their

small size and not HLB, since small fruit from healthy trees have similar lower juice yields. It is important to note that other detailed juice analysis studies have found that there are no new flavor compounds present in juice from symptomatic fruit. Rather, the flavor and quality changes were a result of the lower ratios and altered amounts

of normally occurring compounds, such that HLB symptomatic fruit were very similar to immature fruit.

HLB reduces yield by reducing the average fruit size (diameter and weight) as well as the number of fruit per tree. The degree to which total yield is reduced depends on the percentage of each tree canopy that is

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**Table 1. Juice characteristics for HLB and healthy Hamlin sweet oranges harvested from a commercial citrus grove in Florida during the 2008-2009 harvest season.**

Disease status	Fruit size <sup>z</sup>	°Brix	Acid	Ratio (Brix: Acid)	Juice color	Juice Yield (ml/kg)
HLB	Small	8.2c <sup>y</sup>	0.80a	10.4 b	37 b	584 a
	Avg	9.6 ab	0.7 b	14.8 a	38 a	502 b
Healthy	Small	10.4 a	0.7 b	15.2 a	38 a	618 a
	Avg	9.3 b	0.6 b	15.7 a	38 a	496 b

<sup>z</sup> A sample was collected of the smallest and the average size fruit from each tree harvested. Samples were large enough to yield at least 1/3 gallon of juice.

<sup>y</sup> Lowercase letters indicate significant differences within columns (Tukey's test,  $P = 0.05$ ).



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affected by the disease. Although one of the groves sampled in this study is no longer removing infected trees, we do not yet have enough data to predict how quickly yield changes will occur over time within a given tree. The juice quality analysis from this and other studies clearly indicates that HLB-induced changes are limited to the symptomatic fruit on infected trees. Further studies are under way to fully understand how HLB will affect the quality of Florida citrus products.

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