Evidence-based criteria for reducing the delimitation radius around huanglongbing-positive trees in Southern California

Brianna McGuire[1]
Holly Deniston-Sheets[2]
Neil McRoberts[1]

[1] *Quantitative Biology & Epidemiology Lab, Plant Pathology Department, UC Davis*
[2] *Citrus Research Board*

SUMMARY

This report proposes that the **delimitation radius** for activity around a huanglongbing-positive ("HLB+") tree **be reduced from 400 m to 250 m**. This change is suggested based on the geographic distribution of all trees confirmed to be HLB+ by March 2020, based on a methodology previously used by the Citrus Pest and Disease Prevention Committee (CPDPC) to make operational decisions. This will increase program efficiency and conserve valuable California Department of Food and Agriculture (CDFA) resources by applying them to areas most likely to contain infection. We suggest any labor saved from this change be redirected to other Committee priorities that will be necessary to understand the further spread of HLB, such as sampling specific sentinel trees over time and/or more closely monitoring dooryard/commercial border zones.

BACKGROUND

In the summer of 2018, an analysis of CDFA survey data presented to the CPDPC by Dr. Tim Gottwald revealed that the majority of detectably diseased trees were within 350 m of another diseased tree; at the time, the radius for surveying around an HLB+ tree was 800 m. The CPDPC used this information as the primary scientific evidence to change the delimitation radius from 800 m to 400 m. This change has not been revisited since 2018, though several changes in spatial disease dynamics have occurred since then, and statewide resources dedicated to HLB management are best reviewed frequently to identify potential efficiency gains.

There exists, therefore, both a scientific and economic need to revisit the current survey protocols to determine if they remain efficient and appropriate for the current spatial reality of HLB.

EVIDENCE

The *cumulative distribution function with distance* is, simply put, a method to classify the proportion of observations as the distance between them increases. When applied to HLB+ trees, it can be used to determine the proportion of all positive trees in terms of the distance to their nearest positive neighbor. Using this methodology, 95% of

all positive trees in Southern California were within 230 m of another HLB+ tree, based on data available through March 2020 (Figure 1); this number has stayed relatively stable for at least the last year.

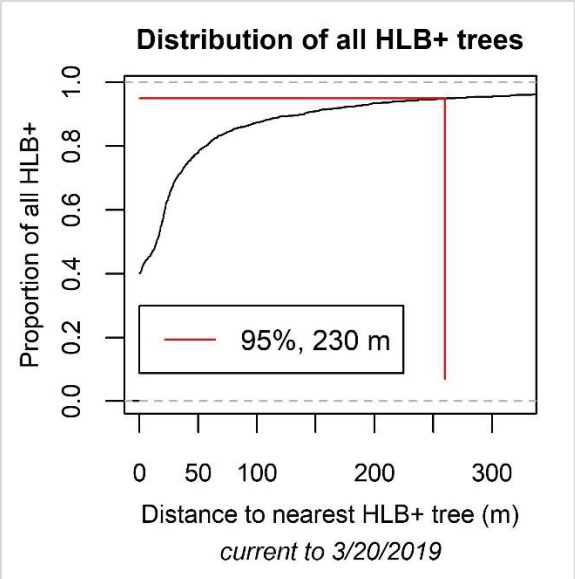

Figure 1: The cumulative distribution function for all HLB+ trees detected in Southern California, indicating that 95% of trees are within 230 m of another HLB+ tree.

VALIDATION

To validate this conclusion and account for possible differences caused by coincidental date of detection of positive trees, the detection order of the HLB+ tree location data was randomized 500 times. For each of these new sequences of detections, the first 95% of the data were then reanalyzed (because 100% of the data would always produce the same cumulative distribution as the normally ordered data). This analysis allows us to examine whether we would come to the same conclusion about the spatial separation of infected trees if the sampling programs had happened to find the trees in a different order.

The distance needed to find 95% of all positive trees stayed between 210 and 270 m in all randomizations, and the maximum distance needed to detect 95% of HLB+ trees never exceeded 270 m in all 500 randomized tests (Figure 2).

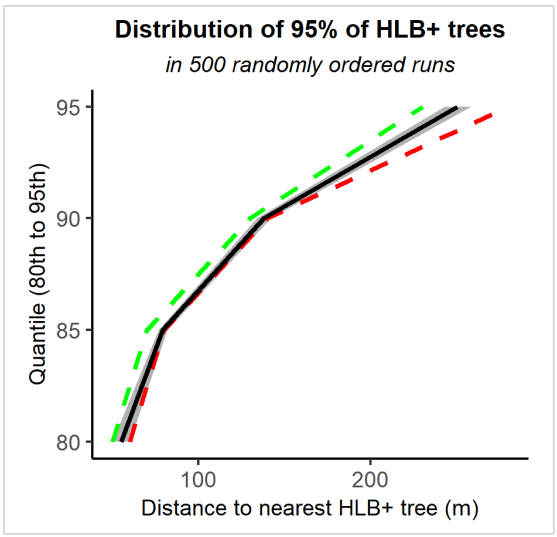

Figure 2: The average radius around each HLB+ tree (black line) needed to encompass the indicated proportion of all HLB+ trees over 500 randomizations of the data, and the standard error (grey shading), indicating 95% of all trees are found at 243 m +/- 9m. Minimum and maximum distances produced from all randomizations are shown in green and red (respectively).

CONCLUSIONS AND CONSIDERATIONS

As in 2018, it appears that a case can be made to reduce the delimitation radius, in this case from 400 m to 250 m. If the Committee wants to add a margin of comfort to the mathematical results, as was done previously, there is still a potential to reduce resource expenditure (Table 1).

However, the Committee may want to consider the possibility that insecticide applications associated with delimitation may be contributing to locally reducing ACP populations around known sources of *Candidatus* liberibacter asiaticus, thereby helping to slow down disease spread. Unfortunately, there is currently almost no direct evidence available to quantitatively evaluate that question. Consequently, we recommend that the delimitation radius for plant survey, sampling, and mandatory pesticide applications be reduced to 250m, and the committee evaluate the possibility of instituting voluntary pesticide treatments between 250m and the previous radius of 400m.

Table 1. The consequences of reducing the delimitation zone around HLB+ trees in terms of reduced area to cover (compared to 400m) and the percent of detected HLB+ trees for each radius.

Radius (m)	Area ($km^{2)}$	Reduction in area/workload	Detected Infection
400	0.50	-	97.5%
350	0.39	23%	96.9%
300	0.28	44%	96.0%
270	0.23	54%	95.6%
250	0.18	61%	95%