# CITRUS ADVANCED TECHNOLOGY PROGRAM

**QUARTERLY & FINAL REPORTS:** Control of Citrus Greening, Canker & Emerging Diseases of Citrus

SELECT PERIOD March 2016

Quarterly Report ◯ Final ●

Proposal Title

Understanding and reducing early root loss in HLB affected trees

| Today's Date | Sponsoring Organization (drop-down) | Category (drop down) |
|---|---|---|
| 9/13/2016 | Citrus Research and Development Foundation | Infection Consequences |

## REPORT UPDATE (500 words-It is not necessary in this public report to disclose your institution's proprietary information or intellectual property.)

HLB-associated root loss was found to occur in 2 phases with an early 30-50% fibrous root loss that occurs before foliar symptoms develop and stays at this level until HLB-induced leaf drop begins. While early root loss averages 30-50% it varies depending on season and root flush. The length of recovery from root flushes decreases with increasing symptom expression in the canopy. The second phase of root loss begins as significant leaf drop begins in symptomatic sectors of the canopy. This second phase is characterized by 70-80% fibrous root loss and dieback of structural roots, starting from the outer tips and moving inward towards the trunk as canopy decline progresses. Surprisingly, HLB also causes a stimulation of root growth. Root growth is increasingly stimulated by Las as the canopy symptoms increase through mild to moderate decline. Root growth only declines once the canopy is in severe decline. From this it could be inferred that fibrous root lifespan was reduced by Las. Greenhouse rhizotron and field minirhizotron (clear tubes buried under grove trees) demonstrated that fibrous root lifespan was reduced from 9-12 months in healthy trees to approximately 4 months in Las-infected trees. The stimulation of root growth and reduction of root lifespan suggest that root stimulation would have a negative effect on citrus trees and that efforts to improve root health should focus on increasing root longevity and supplying water and nutrients in small frequent applications (spoon feeding).

Most of the above studies were performed on Valencia and Hamlin trees on Swingle rootstock. Limited field sampling and greenhouse studies confirmed these results for Carrizo. A survey of Las-induced root loss in commercial and experimental rootstocks demonstrated that most rootstocks suffer the same root loss. In all but one rootstock the percent root loss was identical. Rootstocks with higher healthy root densities suffered higher quantitative root loss, which correlated with increased fruit drop, further supporting the conclusion that inducing root growth is counterproductive to maintaining yield. The only rootstock tested that responded differently to Las infection was UFR-4, which increased root density as symptoms developed and spread through the canopy. It was hypothesized that UFR-4 is susceptible to Las stimulation of root growth, but resistant to Las-induced root dieback. This rootstock was used in the initial rhizotron study, but unexpected technical failures prevented quantification of root longevity and root growth. These technical problems were solved in subsequent rhizotron studies and a second rootstock experiment has been initiated, but is not complete at the time of this report. The resistance of UFR-4 to Las-induced root loss provides a possible resource for studying the mechanism of root dieback.

Considering the changes in root growth caused by Las, phytohormone concentrations were expected to be altered. However, in 3 rootstocks tested (Swingle, UFR-2, and UFR-4) no differences in phytohormones were detected when analyzed with metabolomic approaches. Gene expression analysis did show an upregulation of ABA genes in the roots suggesting a substantial increase in concentration and signalling, but only a very small increase in ABA was detected with targetted extraction and quantification. Whether this also occurs in UFR-4, which appears to be resistant to Las-induced root loss, still needs to be investigated to determine if it could be a fast screening marker for resistance to root loss.


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