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Phloem disruption from HLB infection in canopy and root framework

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Phloem sieve element plugging from callose and phloem protein 2 ligand production have been demonstrated at the leaf level with some phloem necrosis occurring just after or nearly simultaneously. Phloem necrosis also has been reported near the bud union, but it has not been carefully characterized at the trunk, canopy and root scaffold nor canopy and feeder root support structure level. Phloem samples were taken from 1-2 cm, secondary and primary scaffold limbs as well as root flares, pioneer roots and feeder roots. Samples of these were fixed and embedded for light and electron microscopy. In both young potted and bearing field trees, phloem of HLB infected trees showed more phloem cell production (layers of cells) than did healthy trees. Production of new phloem cells appeared to be occurring from already differentiating cells as well as the cambium. Wall distortion and thickening, starch accumulation, cellular content disruption and sieve element plugging occurred primarily in the intermediate cellular zone, at least 6 to 10 cells away from the cambium in trunk and canopy framework limbs. In contrast to stems, intermediate zone healthy feeder root phloem cells had accumulated starch and HLB affected roots had not. Collapsed cells, thickened walls and disrupted cytoplasm were typical in the HLB affected feeder and pioneer root phloem. This intermediate phloem zone may represent the bacterium-affected tissue in the scaffold and support structures while the newest tissues have not had time for bacterial invasion or the effects thereof.