5.3 Anatomical evolution of symptoms from infection with the HLB bacterium


University of Florida, CREC, Lake Alfred, FL, USA

The most visible symptom of HLB is the non-symmetrical mottle chlorosis of leaf blades. Starch accumulation and phloem collapse have been associated with this disease caused by Liberibacter asiaticum. Several hypotheses were developed at our Center regarding symptom development. These were then tested by light and transmission electron microscopy (TEM). 1) Starch accumulation in leaves could be the result of inability to transport sucrose or other sugars across cell membranes or it could be the result of disruption of phloem transport (2). Starch accumulation could lead to chloroplast disintegration and thus produce chlorosis (3). Phloem necrosis could result from bacterial toxins or signals, or from sieve element plugging and carbohydrate deficiency (4). Sieve element plugging could come from bacteria accumulation, callose production or from accumulation of gels from up-regulated phloem proteins. Samples collected and fixed for TEM from various stages of HLB leaf symptom development revealed the following: Starch accumulation occurred after phloem plugging and cell collapse and, therefore, localized phloem carbohydrate deficiency may be a factor. Starch packing of chloroplasts did not rupture the outer membranes, but the inner grana structure was disrupted thus leading to chlorosis, but only in parts of the leaf where phloem plugging occurred. Sieve elements were obstructed by both amorphous and filamentous materials and both occurred in significant amounts, while bacteria were insufficient to directly cause plugging. The amorphous material has been positively identified as callose by immunoassay with gold labeling. The identification of the filamentous material is in progress and is presumed to be a phloem protein lectin. The data support the development of HLB symptoms in the following sequence: phloem plugging and some collapse, sugar backup in localized leaf blade areas, starch accumulation until chloroplast structure is disrupted, chlorosis.