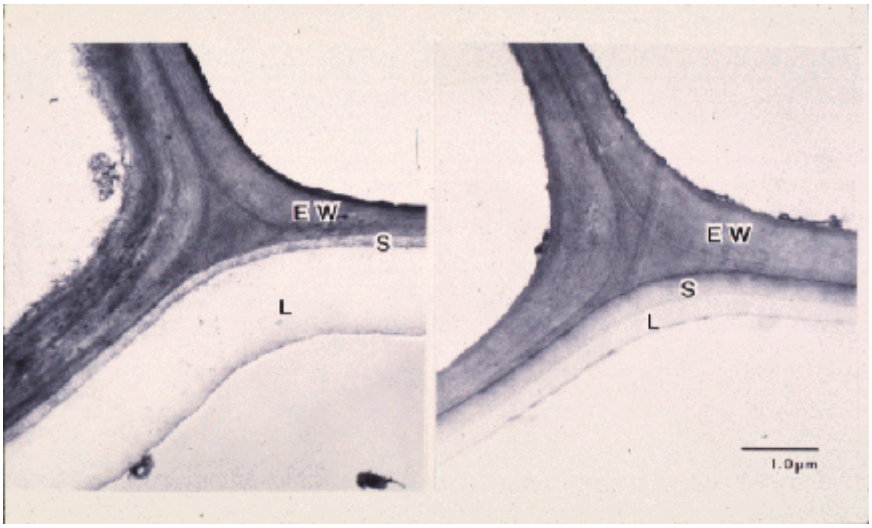
Eissenstat, D.M. and D.S. Achor. (1999). Anatomical characteristics of roots of citrus rootstocks that vary in specific root length. New Phytologist 141: 309-321



Transmission electron micrograph of a transverse section of sour orange (SO, left) and trifoliate orange (TO, right) fibrous root. Rootstocks like SO with relatively coarse fibrous roots tend to have thickened, heavily lignified, outer tangential walls (L) in the exodermis. Also shown are the suberin layer (S) and epidermal wall (EW).

Summary

Among citrus rootstocks, higher specific root length (SRL, root length/dry wt.) has been linked to several specific morphological and physiological traits, including smaller average root diameter, higher root hydraulic conductivity and higher rates of root proliferation. In this study, thickness of the outer tangential exodermal (hypodermal) walls and its suberin layer, number of passage cells, presence of epidermis, and stelar anatomy were examined and related to variation in root diameter of field roots of known maximum age. We also compared root morphology and anatomy of young roots in the field with those of potted rootstock seedlings in the greenhouse. Fibrous roots were measured separately from pioneer (framework) roots. Among the fibrous roots, only the first-order (root links having a root tip) and second-order (root links bearing 1st-order roots) laterals were examined. Among 1st-order field roots, larger root diameter was caused by larger rather than more numerous cells in the cortex. Root diameter of 1st-order roots was positively correlated with both number of passage cells in the exodermis and thickness of the secondary walls of the exodermis in both field and potted plants. Exodermal walls were about 80% thicker in field- than pot-grown roots. In the field, more than 50% of the 1st-order roots examined had less than 30% of the root surface still covered by epidermis with few differences

among rootstocks. In contrast, roots of 19-week-old greenhouse plants had generally 70-100% of the epidermis still intact. There was no evidence of secondary xylem development in 2nd-order fibrous roots in the field; in seedling, pot-grown rootsystems, 75 to 97% of 2nd-order roots had formed secondary xylem despite their small diameter (< 0.8 mm). It is argued that there can be suites of physiological, morphological and anatomical traits in roots that covary with specific root length. Investigations of how root morphology and anatomy are linked to root function, moreover, need to recognize trait variability and the potentially important differences in field- and pot-grown (seedling) roots.