Root structure and function

There are many misconceptions about fruit tree root growth. One is the picture on the right. This creates an entirely wrong idea of tree roots, especially in an irrigated agricultural setting.

Most of the roots of irrigated fruit and nut trees in California are found in the upper meter of soil. They can be concentrated around drip emitters in drip irrigated orchards but in sprinkler and flood irrigated orchards they will spread out to wherever the soil is moist.
Developmental aging of roots.

White and thin brown roots are the primary roots involved in nutrient and water absorption. Woody, mature roots are considered structural roots. But many small thin roots die before going through this whole process and are sloughed off.

Important factors in the root environment affecting root growth and function.

- Soil texture – affects soil permeability, water and nutrient transport through the soil to the root, root architecture
- Soil oxygen – affects ability of root to function (respire). Oxygen concentrations > 10% optimal, 3-5% compromising. More fruit and nut trees die of because of lack of oxygen in water-logged soils than die of lack of water.
- Soil moisture – roots growth where there is soil moisture and obviously there must be water in the soil to take up.
- Soil flora and fauna - fungi, bacteria, worms, nematodes, insects. Effects can be positive and negative. Micorrhizae.
- Soil nutrient status – since nutrient uptake is a primary function of roots, soil nutrients are important for root function. pH best between 5.5 – 6.5 but can vary among rootstocks.

Primary functions of roots

- Absorption and transport of water – water is taken up and transport along a water potential gradient. (See water transport lectures)
- Nutrient absorption – nutrients can be taken up actively or passively depending on the elements. (See nutrition lectures)
- Anchorage – this is extremely important and rootstocks can vary quite a bit even when grown with a common scion cultivar. This is most influenced in a given soil type by root architectural characteristics such a number of fine vs. course roots, rooting depth, angle of major structural roots, etc.
- Storage – as noted in previous discussion of CHO storage, dormant season CHO concentrations tend to be highest in root tissues and can account for as much a 50% of total stored CHO in trees.
- Conversion or synthesis of growth regulators
  - Auxins
  - Gibberellins
  - Cytokinins
  - Abscisic acid

Diagram of water and nutrient movement into roots. Water can follow anyone of three pathways.

A. through the vacuoles of the series of cells (cortical cells (Cort), endodermis layer of cells (End) and cells in the Stele (St)) from the outer part of the root to the inner part to the xylem trachea (Tr).
B. through the cytoplasm (CP) of the same series of cells as A except that the water or nutrients must pass into the endodermis (End) cells in order to get past the Casperian strip (CS) which is a suberized layer that is impermeable to water.
Rootstocks

Rootstocks selection is based on numerous factors:

- Nursery issues
  - Ease of propagation, budding/grafting, uniformity, vigor, etc.
- Orchard issues
  - Anchorage
  - Suckering
  - Compatibility with scions
  - Tolerance to waterlogging
  - Chlorosis, tolerance to high pH
  - Dwarfing
  - Disease resistance
  - Nematode resistance

Use of dwarfing rootstocks

- Most common in apples - the Malling series and now many others.
- Becoming very common with sweet cherries – the Gisela series and now many more.
- Becoming more available for peach – the Controller series and many more new ones from Europe.
- We have one good option for Japanese plums - Citation

How dwarf peach and cherry rootstocks work

- Diameter of the water conducting (xylem) vessels of dwarfing rootstocks are smaller
- This causes the hydraulic conductance of the rootstock water conducting tissue (xylem) to be lower
- This causes the water availability (water potential) in the stems and leaves to be slightly lower
- This causes the elongation of stems to be slightly less and overall vigor of tree is decreased over time
- This decreases the amount of pruning needed
- Decreased pruning reduces the number of water sprouts and this decreases the need for pruning even more, etc.
- This also decreases internal canopy shading and thus increases shoot quality and flower bud development

Apple rootstocks may work similarly but there is probably something else also involved.