Arid Zone Times

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Soil Compaction and Tree Growth

Soil compaction occurs when pressure, exerted on the surface of the soil, reduces or eliminates the air spaces between soil particles making the soil extremely hard and very stable. It can occur slowly as seen in landscape areas with high pedestrian traffic or rapidly from golf carts or the activity of construction equipment. For roadbeds, parking lots, sidewalks and other load bearing soil surfaces, compaction is a means of stabilizing soil and protecting against subsidence that would compromise the structural integrity of the site. When space between soil particles diminishes, water, oxygen and plant root penetration are severely or completely inhibited. Heavy compaction will also affect nutrient uptake by limiting soil gasses, particularly oxygen.

Plant soil nutrients fall into two large groups, those that are passively absorbed by roots in a process called diffusion (and requires no energy expenditure by the plant) and those that are actively drawn into the roots by a process called active transport (and does require energy from the plant). Roots generate the needed energy for active transport and growth by "digesting" nutrients stored in the roots. This digestion, called respiration, requires oxygen and in the absence of oxygen the process stops completely.

Research at the University of Florida showed that in compacted soil (soil dry density of 111 lbs./ cubic foot Ft., approximately 80% compaction), no roots grew deeper than 10 inches with ¼ of them in the first inch and the majority in the upper five inches of the soil. While in uncompacted soil (soil dry density of 75 lbs./cubic foot, approximately 53% compaction), 58% of the roots were deeper than 10 inches and there were no roots in the top inch of soil. Loose uncompacted soil favored the rapid development of a well-distributed root system, enhancing the spread of the tree's canopy and overall growth to maturity. In compacted soil the roots did not develop causing future problems, including wind throw, shallow rooting heaving pavement, and under developed canopies.

Even soils mildly compacted, as a result of general construction job-site traffic (both human and machine caused) can make plant establishment difficult. Reducing the effects of compaction should be an important part of the transplanting process involving both landscape excavation and the use of the native backfill material. The "Tipton Method" (Alternative Planting Methods) is an excellent approach, using a shallow yet broad planting hole to encourage maximal lateral root development. Even this method has limitations when trees are planted in parking lot "cut-outs" or narrow landscape medians that are bordered by a roadway on one side and sidewalk on the other. Here we are trying to create a hospitable planting environment that is surrounded by mechanically compacted soils.

Typically, large areas are compacted before the landscape contractor digs the holes for the landscape plants. When digging, make sure the sides of the hole are roughened and well pitted. This will help create an irregular boundary between the compacted soil and the native backfill encouraging water to infiltrate into the surrounding soil. Better lateral water distribution will lead to a more dispersed root system. Obviously when planting in compacted soil, the wider the planting hole the better. To further promote water penetration, backfill soil should mimic the soil character, pore size and texture of the surrounding soil (prior to compacting).

Under evaluation by the City of Davis and the University of California at Davis is a "Structural Soil Mixture" developed by researchers at Cornell University. "Structural Soil Mix" is made up primarily of angular crushed stones 0.75 to 1.25" mixed with a clay loam soil. When the mixture is compressed, the rock will support the weight of traffic but the spaces between the stones that are filled with soil, will allow water penetration, oxygen exchange and root development under the paved areas. It is hoped that this mixture will create an environment suitable for root establishment yet structurally stable enough to support hardscape, sidewalks, parking surfaces and roadways.