

Orchard Soils and Their Influence on Apple Root Systems

Dr. Ron Perry
Chairperson and Professor
Department of Horticulture Mich. State University
East Lansing, MI

Apples have root systems that inhabit the soil profile with relative permanence. The fact that roots develop at the mercy of underground conditions means that soil characteristics have a major impact on development, survival and orchard performance. In the Great Lakes, soils are extremely variable due to the nature of how they were formed through glacial retreat. Soils in New England were formed as a result of Glacial action (Wisconsinan advance in all of NE) which deposited unsorted materials within and under glacial ice. The material ends up being a heterogeneous mixture of particle sizes from rocks to clay. Basal tills left by glacial retreat formed drumlins and moraines which characteristically have dense restrictive layers which inhibits water movement and root penetration. These hard pans can occur on a hill (drumlin or moraine) which perches water and floods root systems. Glacial outwash (melt water) left behind plains and deltas with stratified layers of sand and other materials. Following glacial retreat, Eolian sands were spread across the surface for some areas in New England (Northern Michigan also). Therefore, some sites have a surface layer of mineral sand in the top 1.5 – 3 feet. When it comes to orchard sites, those which possess elevation changes and slope are not only helpful in cold air drainage, they often can be beneficial to relieve soil drainage. The exception would be in drumlins and moraines where a hard pan perches water on slope.

What is a desirable orchard soil? Basically, historical research has indicated that in general, fruit tree root systems need about 3 feet or 1 meter of cultivatable well drained soil to support good consistent crops and be long-lived. Tree roots prefer loamy soils with good Cation Exchange Capacity to retain nutrients and good moisture holding capacity. Soils with coarse texture (sandy soils) may provide excellent internal drainage, but often are poor in water and nutrient holding capacities. We often see apples on dwarfing rootstocks which struggle in such soils and rarely fill their spacing in Michigan. The other extreme in soil conditions for apple root systems is where the soil has fine texture (heavy clay) which causes problems related to poor aeration and conditions that foster Phytophthora root rotting. Plant roots absorb oxygen and release carbon dioxide.

Most terrestrial plants can not transfer oxygen from the above ground to the below ground portions of the plant. Therefore, adequate root respiration requires the soil to be aerated. Gas composition in soil will be similar to air if well aerated. Respiration by plants and microbes can increase the amount of carbon dioxide by 10 to 100 times if aeration is poor. Under saturated conditions, oxygen content of soil can approach zero. Plant growth depends more upon the occurrence and duration of periods of oxygen deficiency than upon average conditions. Anaerobiosis (wet feet), caused by oxygen stress, occurs when the rate of supply is less than demand. The detrimental effects are lessened in winter, very early spring and late fall when trees are less active or have less

leaf area. Once a tree is actively growing during the season, it is very vulnerable to stresses caused by wet feet or drought.

Soils which are shallow, caused by a hard pan in the B horizon, can force roots to develop near the surface where soils dry readily during the summer. Many or most of the dwarfing rootstocks that have limited root systems such as M.9 to M.26, which do not handle soil stresses as well as more vigorous rootstocks. More vigorous stocks should be selected where soils are inherently more sandy or where soils are shallow.

Methods to Alleviate and Improve Soil Structure in Orchards

We prefer to select a good site which has a desirable orchard soil with adequate depth. If the soil is heavy or wet, then seek methods to alleviate problems. These include subsoiling and mixing, moldboard plowing (effective down to 1-1.5 ft deep). The objective is to provide good mixing of A and part of B horizon. The effects on rooting are long lasting. Deep plowing or mixing using slip plows is possible at a cost of \$500 or more per acre. Installation of a tile drain system can provide relief for heavy wet soils, but only if designed correctly. Raised beds is another effective method, but requires much earth moving. This technique has a long history practiced by the Romans.

Our experience is fairly positive but we found that single row beds dry too fast and are less effective than wide beds. There are over 750,000 Acres citrus on beds in FL. We evaluated this technique for cherry, peach and apples from 1981-1990. Peach and Sour Cherry trees had improved productivity and survival after 10 yrs on medium size, wide bed (30 cm high, 2 m wide). Apples on MM 106, were not affected by bed treatments.

Soil Preparation and Management for Planting an Orchard

In preparation to establish a site the following spring, subsoil when dry, during the previous summer. If mechanical planters are used for apple, plant so that the union is set at a minimum of 4 - 6 inches above ground line. If holes are prepared using an auger, set the tree so that the union is at a minimum of 6-8 inches above ground line. Expect more settling following planting with augered holes. Do not fertilize until mid summer. Roots can and should be pruned back to fit a hole / furrow. Keep root systems moist and back fill with soil to remove air pockets. For apples on dwarfing clonal rootstocks, if you must error in depth, make it on the side of shallow planting and not deep plant. Scion rooting, common in apples (not in stone fruit), can mean disaster later, resulting in extreme vigor for the spacing. Use a 2"X4" (2-4 ft long) piece of wood to help as a reference. Place the 2X4 on its edge adjacent to the planted tree (perpendicular to the row) to check its depth. The union should clearly appear above the edge of the board indicating that it is at least 4" high. A 2X6" board may serve best for where the desired union height is for 6". The same 2X4 or 6 can be used for union height reference for stone fruit if the board is placed on its flat side so that the union height appears 1-2 " above ground level.

To suppress the impact and population of Dogwood Borers, we have been recommending to growers to form a berm of soil above the union during the first 2-3 growing seasons. Once burr knots, commonly formed on dwarfing rootstocks, have extended into the soil (berm), larval infestation is largely avoided.