Managing Soils in Pecan Orchards

Cooperative Extension Service
College of Agriculture and Home Economics

Guide H-649

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This publication is scheduled to be updated and reissued 5/05.

Pecan trees perform best in deep, well-drained, sandy soils including loamy sand, sandy loam, and silt loam. The more the soil deviates from these ideal textures and profiles, the more tree performance declines. Soils that frequently present problems are—

- shallow upland soils with a calcic horizon (commonly referred to as a caliche layer),
- clay soils with inadequate permeability,
- soils affected by salts, especially sodium (Na), and
- soils affected by fluctuating high water tables.

Tree performance depends on the soil. This strong dependence is undoubtedly related to the nature of pecan trees, which are susceptible to water stress, salt stress, waterlogging, poor aeration, and hard soil. The soil's physical characteristics should allow the plant to get enough air, water, and nutrients, creating good conditions for root growth.

Soils are made up of minerals (sands, silt, and clays), organic matter, air, and water. Distribution, density, and arrangement of these components determine the soil's physical properties, particularly texture and structure.

Although physical problems include poor soil texture and structure at the surface, most problems develop due to deeper soil irregularities that affect rooting. Rooting problems can be caused by—

- abrupt differences in texture in the soil profile (called layering or stratification);
- dense clay layers in the profile (known as claypan);
- "cement" layers that present absolute barriers to rooting and water penetration ("caliche" can be included in this classification);
- and compacted layers due to extensive cultivation of soils, especially when soil moisture content is high.

Correcting these irregularities improves water drainage and aeration, improves root growth, and increases a soil's water-holding capacity.

Evaluating the Soil Profile

Proper diagnosis of a soil's physical problem is essential to developing an economic, effective resolution. Identifying the orchard's soil types and soil profile also helps tremendously in managing pecan orchard soils.

For most farming areas, there are accurate maps of soil types and characteristics. These maps were prepared by the Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) of the U.S. Department of Agriculture in cooperation with local universities. The maps are available from your local NRCS office or your county Extension office. A soil map contains information about soil texture, depth, presence of restricting layers within the profile, and chemical limitations for specific areas. Soil maps are a good source of information and offer accurate information about fairly small areas.

In addition to using soil maps, be sure to evaluate your soil profile to a 7-foot depth in all soil types encountered in your orchard.

A backhoe is an extremely useful tool in site evaluation and diagnosis of soil problems. Further, backhoeing can be used to determine the extent of a problem within the profile or across the field. Trenches dug in different areas of the field easily reveal the nature of any textural strata or hardpan that would limit plant growth. Such investigation also is extremely valuable in determining the appropriate and economic modifications to eliminate or mitigate the problem.

As an alternative to a backhoe, use a soil probe (which is used to pull undisturbed soil cores from the profile) or shovel for site evaluation. Although this method is inexpensive, it is time-consuming and is not as revealing as digging 7-foot deep trenches.

Selecting an Irrigation System

The main objective of evaluating the orchard soil is to use appropriate soil management practices so that trees have enough water throughout the season. Knowing the orchard soil also helps growers select the most appropriate irrigation system.

Many orchard sites have physical irregularities within the soil profile, but a uniform supply of water can be distributed to each tree using a pressurized irrigation system (such as microsprinklers, drip, buried drip tape, or sprinklers). Such systems usually do not require uniform slope or profile to ensure water availability to each tree, although sometimes it's difficult to reach uniform water pressure. Water can be supplied frequently (such as daily or every two or three days), so a grower can match the infiltration rate of the soil to the orchard's evapotranspiration rate.

Gravity-driven irrigation systems (flood or furrow systems) usually are considerably less expensive than pressurized systems both to install and operate, but they require relatively level land and a uniform soil profile to ensure equal water availability to all trees. Most orchard soils do not enjoy these ideal characteristics and instead have variable water storage capability and infiltration rates that are difficult to manage without modification.

If the soil for a future orchard is fairly regular, the grower can obtain uniform water application using the cheaper flood or furrow gravity irrigation systems by leveling land with slight variability in terrain prior to planting the orchard. A uniform slope must be provided, the extent of which is determined primarily by the soil's infiltration rate. Soils with slow infiltration rates (such as clay) should be leveled to less grade than those with higher infiltration rates (such as sand). Other factors that influence grade are the capacity of the pump or other water discharge, and the length of the irrigation run.

Improving Drainage and Aeration

Tilling the soil deep into the profile ensures subsurface water drainage and aeration, increasing the tree's potential rooting area and, thus, it's ability to extract water. If a future orchard is to be on a gravity-driven irrigation system, deep tillage before planting is recommended. This will improve the soil's infiltration rate and even out irregularities in soil texture.

To improve water drainage in orchard soils with stratified (layered) soils, use a backhoe to dig a pit for each tree. Determine the size of the pit by the depth of the problem. Backhoed tree sites usually are 3 to 4 feet wide, 4 to 6 feet long, and 6 to 7 feet deep. This method is expensive, so it is best adapted to small acreages.

This method also is most effective for soil with a layer of clay on top of a layer of sand. After trenches have been dug, clay and sand are mixed at least on a 1:1 ratio, but a 1:2 ratio is better. For example, for a 1:1 ratio, a soil with 2 feet of clay on top would require 2 feet of sand for a 4-foot deep trench. For a 1:2 ratio, a 6-foot deep trench would require 2 feet of clay and 4 feet of sand.

Do not use rippers (subsoilers) to modify stratified soils. Rippers are designed to shatter cemented layers, not mix strata of varying soil textures. In no more than two years following ripping, the layers in stratified soils will reform, nullifying the objective of the operation.

Ripping (or subsoiling) is the recommended method of breaking cemented hardpan layers in the soil profile. Breaking the layer is usually all that is required to ensure water drainage. Although slip plows contain a ripping component, their use in hardpan soils is limited because of the excessive power required to fracture the claypan. Other soil modification methods (such as the use of moldboard plows, disc plows, trenchers, and backhoes) are not recommended because they are slow to break the claypan and they cannot thoroughly break up (or through) the cemented layer. It is generally held that if the hardpan cannot be broken by ripping, the land probably should not be considered for trees.

Rippers also can be successful breaking hardpans caused by use of heavy equipment (a condition known as plow pan). Shallow water penetration, die-back of deep roots, yellowing of leaves, die-back of shoots at tree tops, and loss of tree vigor are sure signs of water drainage problems. In well-drained, deep sandy loam or silt loam, the root system of pecans penetrates easily to adequate depth. But compacted soil or plow pan slows the soil's water intake and decreases the depth of water penetration. These problems combine to dry out the deep roots and waterlog roots in the upper soil layers, resulting in their dying back.

Adjusting for a Fluctuating High Water Table

Soils affected by high water tables are common in irrigated orchards established along river basins. Although pecan trees can develop shallow, lateral root systems, a high water table may not be a serious problem—as long as the table is stable and the water is both low in salts and high in oxygen. River water, for example, is typically well-oxygenated because the water is in constant motion and the oxygen is replaced as the water moves.

The problem occurs when the water table fluctuates. The root system that is adjusted to deep water tables cannot function when the table rises, so trees experience difficulties taking up water. This leads to physiological disorders, starting with die-back of the top branches.

When the water table rises too high, feeder roots become subject to high salt levels as the salts lower in the root zone are brought to the surface. Tree mortality following the rise of water tables is associated primarily with high salinity rather than with too much water.

It is best that the soil for any pecan orchard has at least 7 feet of depth above the water table so the root system has adequate room in which to expand.

Remedies for high water table problems are specific to each site; poor results often are associated with poor drainage measures. Pecan orchards in the Southwest typically encounter three types of drainage problems.

The first is the presence of a sand subsoil under clay soil, which causes a perched water table. This problem is usually controlled by deep trenching. Breaking through the clay subsoil and mixing clay and sand in the trenches dramatically improves soil drainage.

The second type usually occurs in old depressions or lagunas (where drainage was poor to begin with) that were filled during irrigation project developments. Subsurface tile drains or open drains usually are used to correct this problem. However, do not use open drains in sand or silt because they can cause extensive caving in.

The third type usually occurs as a result of canal seepage or, at times, excessive flow in adjacent rivers or creeks. Canal lining or interception drains (either subsurface or open, depending primarily on soil texture) commonly are used to deal with these problems.

Once the water table begins to recede, and if high salt levels are present in the soil, begin salt leaching with irrigation water in alternate rows. This minimizes the amount of drainage. Otherwise, flooding the entire orchard often results in a resurgence of the water table, which makes it difficult to leach the salt.

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