SOIL DRAINAGE FOR TREES

by Kenneth D. Meyer

The San Francisco Bay Area contains an area on the western side of the bay known as the Peninsula. It is a strip of land about 20 miles long and 8 miles wide from the bay to the Pacific Ocean. This land is composed of mountainous areas with coast redwoods (*Sequoia sempervirens*) and Douglas firs (*Pseudotsuga menziesii*) on the Pacific Ocean side, and sloping areas with rolling grassy hills on the bay side. Coast live oak *(Quercus agrifolia)* are the predominant tree species in this area. This is also the area of greatest population and homebuilding activity.

We have found that the oaks on the San Francisco Peninsula suffer more from ground disturbance than any other cause. More specifically this disturbance is in the form of excess soil being placed over the root zone and root crown which often includes irrigation water being added to a species that prefers only 20 inches of rain each year.

Much of our work involving the care of trees in poorly drained areas is the result of empirical observations. If the tree displays symptoms of poor drainage, including sparse and chlorotic foliage, we will inspect the site thoroughly and make necessary corrections. But, ideally we try to inspect a site and make corrections before a site is developed or trees are affected.

One of the first things we do when presented with a site plan is to study the plan for soil cuts and fills, impediment of surface or ground water, channeling of surface water or compaction over the root zone. We will visit the site and inspect the existing trees for vitality. This is accomplished by a general inspection of the trees, increment borings, and use of the Shigometer. We will dig a hole to a possible depth of 4 feet and observe the soil. Questions to be answered include the soil texture, moisture and whether impervious layers exist. We are conscious of water percolation and the problems of compaction.

In larger areas power auger drilled holes or openings dug by a backhoe are best for observations. A hole may be left open and filled with water to observe the rate of percolation. If we find water has not filtered down at the rate of ½ inch per hour, we suspect drainage problems. Another way to check the rate of percolation is described in a University of California Extension Bulletin (Leaflet 2664) in which a 3" hole is drilled at varying depths, most practically from 1 to 5 feet. A 3" aluminum (or plastic) pipe is inserted to extend from the bottom of the hole to several inches above the hole. A quart glass jug filled with water with a rubber stopper and a plexiglass tube through the stopper is inverted over the pipe. The plexiglass tube goes to within 2 inches of the bottom of the hole. The water loss within the jar can be noted.

Relationships can be drawn between different areas of the landscape. This could be checked again upon completion of the landscape project. Another simple and practical check for water accumulation is to install a 3" perforated plastic pipe in the ground to a depth of 5 feet. Using a dip stick, one can observe if water is raising to the root area of the tree. This is particularly useful for tree wells filled with rock.

We have found that the problems of poor drainage are not unlike those of poor soil aeration. And, it may be that these two problems are often acting together. The symptoms of wilting, browning of leaves (usually without leaf fall if the effect is sudden) half developed buds, chlorosis, and leaf tip burn may appear in one or more numbers on a tree. On more advanced cases, especially when crown rot organisms are involved, weeping or oozing at the lower trunk and bark cracking or checking may be observed. If anaerobic bacteria are present, we often find a pungent "fermenting" smell in the soil. This is sometimes accompanied with a greenish brown coloration of the soil.

If we encounter a site where poor soil drainage or aeration cannot be entirely corrected, plant selection may be of value. Some trees, such as bald cypress, eucalyptus, sycamores, and willows are known to withstand wet soils and periods of flooding over many days. Others, such as hawthorns and live oaks may succumb in a short period. Eucalyptus were used to lower the water table in parts of the United States which then allowed the planting of other species of trees. Plants also cause aggregation of soil particles by root pressure, making larger air spaces. As roots grow and die, they form channels for water percolation. This effect will increase soil percolation. We, therefore, may suggest planting select species to "loosen" the soil.

Let us assume that on a new construction site the soil profile indicates a hardpan two feet down. This will restrict drainage and possibly kill the proposed selected species to be planted. The soil can be rototilled, disked, or ripped to break through the hardpan. This is best done when the soil is dry to permit better fracturing. Once the soil is turned, wetting and drying will help break down the clods. Clods that do not break down are removed and the soil prepared for tree planting. If the soil is still not permeable, gypsum may be incorporated if the pH is too high or limestone if the pH is too low. Both products will help flocculate the soil and improve the drainage. Their action, however, may be temporary (2 years) requiring additional treatments. Several soil chemical additives exist which may increase percolation. These products, such as "Water-In" and "Pentex" are detergent like and permit the water to penetrate hydrophobic soils. We have not tried these products and, therefore, cannot comment on their effectiveness.

Other means of overcoming hardpans include dynamite, compressed air, and vertical mulching. If dynamite is permissible and used, be careful that potholes with poor drainage are not created. Thin sandstone layers were fractured successfully in one area of the San Francisco Bay area by releasing air under pressure in sudden large volumes beneath the sandstone layer. The heaving uplift of the ground apparently fractured the sandstone. Vertical mulching involves drilling 3 inch diameter holes to 3 feet deep to allow water and air to penetrate. Handheld power driven augers, either chain saw conversions or specially designed auger drilling equipment, are available. The holes are filled with organic material such as rice hulls or an inorganic material such as perlite. A pattern for such drilling may be from midway out of the dripline to one-half the distance beyond the dripline. The diameter size of the auger can be increased for groves of large trees and lowered for small trees. Consideration must be given to damage of roots from the auger. However, the benefits appear to outweigh the losses. We have dug up columns in the soil from previous years treatments and found roots massed in the area. Air and water corridors can also be bored into the soil hydraulically. We use a ½" steel pipe 4 feet long with 300 pounds pressure to force the water down. The pattern of placement is similar to vertical mulching. It should be understood that with this method there is a temporary introduction of water which may aggravate existing drainage problems. Should this be the case, use of a soil auger would be preferable.

We generally do not advise our clients to change the texture of a soil by adding amendments. The amount necessary has been estimated by others as up to 50 percent of the native soil by volume. On an entire site this volume is usually prohibitive. If fill is scheduled to be brought in, we generally advise a texture that is equal to or coarser than the existing native soil. Placement of mulch, such as wood chips or straw, over the site can be beneficia in reducing compaction from heavy equipment. The breakdown of the organic material will aid in increasing soil porosity. Mulch placed on top of the soil should be 6 to 12 inches thick.

As mentioned earlier, it is necessary to check all structures and "improvements" on the site plans for drain patterns. If downspouts lead to a prized specimen tree that requires dry conditions, the increased water may be harmful. It is a simple process to carry this water away from the tree with drainpipes. If driveways, walkways, and other paved surfaces lead to a tree, resurfacing or construction of berms or drains to intercept the water may be necessary. Harris, in his book, Arboriculture (Prentice-Hall, 1983) describes a French drain to intercept water flow. It is basically a trench up to 4 inches wide and five feet deep filled with ¾" drain rock. The trench may have a fall of 1" in 10 feet. It intercepts and leads water away from the area. We have installed such systems uphill from trees that had diverted intermittent springs leading to the trees. On two such occasions, the construction of homes with deep foundations changed the water course necessitating such drains. Occasionally a problem presents itself where downhill drainage has been impaired and water backs up, injuring a tree. Weep holes in the water barrier (wall or bulkhead) or a French drain between the tree and the barrier may be effective in eliminating this problem.

Perhaps one of the most prevalent problems of poor drainage is the application of too much water to the soil and the trees. It has been my experience that overwatering occurs most often with automatic irrigation systems. Education of the user to regulate the systems to allow only the necessary water will solve many problems. Directing heads away from vulnerable species of trees will also help to prevent crown rot problems.

Local development of two areas on the San Francisco Bay mudflats has resulted in unique drainage problems. The water table, besides containing saline water, varies with the tides. In an effort to drain the area, perforated pipes were placed beneath the soil in certain areas. These drain pipes lead to pumps which operate when the tides are high. Agriculturally, drain pipes may be 100 feet apart and 3 or more feet deep. In landscape uses, drain pipes can be 10 to 30 feet apart and up to 3 feet deep. In the landscape one should use 3 or 4 inch plastic pipe unless larger diameters are warranted. We have designed many such drain systems, sometimes incorporating them with irrigation and aeration systems. These systems are often installed where large amounts of fill are to be placed over the root zone. Their purpose is to carry water from the tree well and the soil interface of the parent and fill material. Whereas it has been past practice to lay drain rock covered with straw, fiberglass, or tarpaper over the entire root zone prior to applying the fill, new research suggests that this may actually decrease movement of water from the fill to the parent material. This would discourage rooting into the fill as the soil may remain in a saturated condition. The drainage system must lead to an area where drainage can accept the water, unless equipment exists to pump it away. Sometimes construction of a sump away from the tree filled with 1 ½ inch drain rock is sufficient to hold the excess water and allow it to gradually percolate out. The depth and spacing of a drainage system is based on the depth of the fill. If no fill exists, the depth and number (spacing) are dependent on the soil texture, depth of impervious layers, and the amount of water to be carried away. As a general rule, the slower water moves in the soil, the deeper and closer together the drain pipes should be. The fall for adequate drainage should be at least 1" in 10 feet. Plastic pipes should be cemented together and laid on 2 inches of gravel. The perforations should be down and covered with the gravel which helps filter out sediment that rises with the water to enter the system. We generally cover this with tarpaper to keep the soil from washing into the gravel. One must be careful to avoid root injury from power digging equipment. Hand digging and tunneling below roots greater than 2 inches in diameter should be practiced in delicate areas. The system should include standpipes to the surface for oxygen and carbon dioxide exchange. All systems should slope away from the tree. If a tree well is installed about the tree, 3 or 4 spokes leading away to drain the well are necessary. In some cases, a single drain from a tree well is adequate.

In conclusion, one can see that drainage problems around trees can be corrected in a myriad of ways. Hindsight as usual is far more accurate than foresight. I live in a home which unbeknownst to me at the time of purchase was situated on an old tennis court. Everytime I plant a tree I must break through the old court located about 1 foot beneath the fill. I would have saved much anguish and backbreaking labor if I had only used foresight and inspected the soil prior to purchasing the land.

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