



Landscape Notes



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Volume 19 #2

March 2006

Some factors about soil that you need to know to understand the biology of the oak tree in California.
(This article is reprinted from a handout and presentation given by Jim Downer at a regional meeting of the Western Chapter of the international Society of Arboriculture)

Where Oaks Grow

Oaks grow in xeric, mesic and hydric soils and have evolved to do so over many millions of years. Long and Jones (1995) suggest that these are not mere phenological differences but true evolutionary adaptations based on their observations of growth of seeds from the different environments in a single laboratory environment. In Southern California, we have several oak species that are native to our valleys, canyons and mountains. Of these the coast live oak (*Quercus agrifolia*) and the Valley Oak (*Q. lobata*) and to a lesser degree the Engleman oak (*Q. engelmannii*) comprise the important and protected species in landscapes. Also abundant but not as important is the scrub oak (*Q. berberidifolia*). Since scrub oak does not form large trees, it has not been given the same degree of protection from removal as other species. Scrub oak is however abundant in Southern California oak woodlands. Each of these species has adaptations to differing soils and soil moisture environments. Coast live oak grows on shaded northern slopes of most of our foothills and along and within the coastal valleys of California. It prefers areas where moisture is conserved (north slopes) if soils are young or poorly developed, or valleys where soils are deep and water abundant. The valley oak only grows in the middle of valleys where there are deep alluvial soils that have abundant water holding capacities. Scrub oak grows on steep slopes of north and south facing aspect, at lower elevation on poorly developed soils with low water holding capacity.

Roots

Breda et al., (1995) found that *Quercus* spp. had up to 81% of total roots as fine roots (<3mm). They also found that 85% of all roots were in the upper 70cm of soil. Only fine roots were found in lower layers (80cm to 1.6m depth). Root prevalence was inversely correlated with bulk density of the soil. Root densities are regularly correlated with soil organic matter in many different studies. Maintaining the mulch layer under oaks is critical to keeping a high number of roots in the upper layers of soil. Coast live oak is particularly efficient at dropping large amounts of biomass (coarse woody debris) to maintain a copious mulch layer (Tietje et al., 2002). The maintenance of mulch layers also assists in the survival of fungi that form ectomycorrhizal associations with oak roots.

Water

For any given species of oak, its ability to extract water from the soils it grows in will depend on the density and distribution of its roots in that soil (Callaway, 1990). Some European oaks such as *Q. robur* (pedunculate oaks) and *Q. petraea* (sessile oak) partition their root systems above and below clay accumulation layers in soil. The upper layer is readily depleted of water by early summer or late spring and the trees then rely on lower soil layers (80cm-1.6m depth) to draw much of their water (Breda et. al., 1995). In Southern California, oaks have evolved to survive hot, arid summers with minimal or no rainfall. Growth occurs in the spring after our cool wet winters. Many oaks occur in or near urban areas and may or may not be adapted to urban horticultural practices. When oaks are

cultivated as ornamentals they may become accustomed to regular irrigation during the hot summer months. This is especially true of newly planted our nursery stock. It is foolish to think that because *Q. agrifolia* is adapted to hot dry summers that newly planted trees do not need irrigation. Until oaks are well established in landscapes (a process that may take years) regularly scheduled irrigations may be necessary.

Microbiology

Soils are composed not only of water, air spaces and solids but also of living organisms. Trees themselves inhabit soils and exert changes on their physical structure. Roots growth through soil and break it into aggregates thus increasing its porosity and ability to take in water. Growing with these roots are their mycorrhizal systems that also change the soil they occur in. Oaks are highly mycorrhizal and are almost always well colonized. The importance of mycorrhizal hyphae in soils has long been recognized by mycologists and ecologists, but poorly understood due to the methodological difficulties in quantification of hyphae in soils. In Recent years, studies have increased on Glomalin, an exudate of vesicular arbuscular mycorrhizae that has been attributed to many changes in soils. Glomalin has also been used as an indicator of fungal biomass in soils (Wright, and Upadyaya, 1999; Kristov et al., 2004). Use of Glomalin concentration to determine density of fungi is difficult because arthropods consume it, and glomalin production cycles up and down throughout the year. The production of polysaccharides such as glomalin and other compounds by fungi helps to cycle carbon in the soil and also results in physical and structural changes in soil increasing its porosity and water infiltration. This is all dependent however, on a vibrant population of soil arthropods which are necessary to solubilize glomalin and other fungal byproducts so that they can move through the various soil profiles. Microarthropods are abundant in the litter layers of soil and thus their activity is directly tied to the presence and function of fungi in soils associated with oaks (Kristov et al., 2004). Microarthropods in soil are often considered as distinct from those in litter however, the effects of organisms in litter ultimately may have influences on underlying soils and their microfauna.

Soil Aggregate Stability

For soils to take in water and hold it, they must possess a good aggregation of particles. Aggregate stability maintains water infiltration rates, tilth, and aeration necessary for good root growth (Emerson et al., 1986). Formation of microaggregates leads to consolidation into macroaggregates and ultimately, reductions in soil bulk density and increased water holding capacity and soil aeration. Most researchers believe that this process is assisted by the presence of extracellular polysaccharides produced by fungi. Wright and Upadhyaya (1998) found that Glomalin is highly correlated with aggregate stability in soils. Glomalin is extremely persistent in soil and although it is solubilized by microarthropods, it still has a very long lifetime surrounding microaggregates in soils. Glomalin is insoluble in water and creates hydrophobic conditions around soil particles. This may facilitate the passage of water through soil micropores and prevent structural breakdown of the soil.

Allelopathy

Various studies have demonstrated that oaks can have allelopathic effects on surrounding plants. Allelopathy is the production of plant inhibiting chemicals by one plant to regulate the growth of others in its vicinity. One important group of chemicals produced by oaks is tannins. They are produced in leaves and litter and also directly by root systems in soil. Tannins are inhibitory to many organisms. Salicylic acid and other organic acids are also produced by oaks and are toxic to other plants. Allelopathy is species specific for the oak in question and the species that is inhibited. For additional information on the allelopathy of oaks see the review by Scherbath (2001).

Soil disturbance and its effects on oaks.

The oaks mall in thousand oaks California was developed in the 1975 and arborist Paul Rogers monitored the status of the existing white oaks for 23 years until 1998. Both coast live oak and valley oak were subject to cuts and fills around their root zone. Mr Rogers observations are summarized in table 1. Both cuts and fills were devastating to each species of oak. Although there were more white oaks that survived fill than any other surviving species/treatment combination, there were also

more white oaks on site that received fill than were cut. The overall effects of cuts or fills were devastating to the oaks on this site.

Cuts are not always seen as harmful to trees. The most dramatic effect of grade cuts near a tree is the removal of roots. According to Hamilton (2005), a soil cut midway between the canopy edge and the tree trunk will result in approximately 30% root loss and should not cause lasting harm to a vigorous tree. Hamilton further asserts that severe root pruning does not affect the value of the tree for the general public. Dr. Fred Roth (personal communication) also concurs; it is hard to harm a tree by routine root pruning for sidewalk removal. This is likely true for many species of trees grown as ornamentals in irrigated parkways. However, the data in table 1 suggest that for oaks, severe root pruning is costly, at least for live oaks. Similar results were observed by Dagit and Downer (1997) in a long-term monitoring project of transplanted coast live oaks. The process of boxing and transplanting resulted in heavy root loss from which a majority of the trees never recovered. Discrepancies between studies on cuts may be due to the amount of cutting. When trees are boxed, extensive root cutting is done on the entire tree not just a single side.

Adding soil over the surface of an established tree root system can also pose problems, however; most research does not bear this out. Research by Costello and McDonald (1998), showed no effect of adding 12 inches of fill soil over root systems of young cherry trees. In a study of fill soils on eastern white oaks (*Q. alba*), Day et al. (2000), found that raising the grade around the study trees did not have any adverse affects on their growth or survival—in fact, they grew roots abundantly into the fill soil.

Conclusions

Oaks are native to Southern California and are adapted to our hot dry summers. However, they also have preferential growing locations. When we grow oaks where we want on various kinds of soils, we should expect variable growth responses. Additional summer water applied when necessary, is helpful to maintain vigor and produce adequate growth, provided disease causing fungi are not present. Maintenance of a natural mulch layer is an important feature of all oak soils and should be considered as part of oak horticulture. Don't rake up the leaves under oaks!!

Table 1. Effects of cuts and fills on coast live oak and valley oak survival in Thousand Oaks Ca.

	Tree Count	No impacts	Grading	
			Cuts	Fills
1975				
Valley Oak	47	10	1	36
Coast Live Oak	17	7	10	--
Total	64	17	11	36
1998				
Valley Oak	17	9	1	7
Coast Live Oak	4	4	-	-
Total	21	13	1	7

Data reprinted courtesy of Paul Rogers, Ojai, CA.

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