

# SILVICAL CHARACTERISTICS OF THE FIVE UPLAND OAKS

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**ABSTRACT.** The five most important upland oaks of eastern North America are white oak (*Quercus alba*), chestnut oak (*Q. prinus*), northern red oak (*Q. rubra*), black oak (*Q. velutina*), and scarlet oak (*Q. coccinea*). Of these, white oak and northern red oak are most characteristic of northern aspects, coves, and lower slopes, while chestnut oak, black oak, and scarlet oak are typically found on upper slopes and dry ridges.

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## WHITE OAK (*Quercus alba* L.)

**W**HITE OAK is the most important commercial timber species of oak in the United States and probably in the world. It ranges throughout most of the eastern United States except for northern New England and peninsular Florida. Mean annual temperature varies from 45°F. in the northern part of its range to 70°F. in east Texas and north Florida. Optimum conditions for growth are found on the western slopes of the Appalachian Mountains.

White oak grows best on northern lower slopes and in coves, but is found in wet bottom lands and on any upland aspect except extremely dry, shallow-soil ridges. Altitude is seldom a factor except in the northern parts of the range and in the higher Appalachians (Core 1966).

White oak flowers appear in spring as the new leaves unfold, and the acorns ripen about October of the same year. The acorns germinate soon after they fall to the ground. This is a disadvantage because often the roots do not have time to penetrate the soil before they are killed by freezing. A heavy

cover of litter is desirable. The germination capacity ranges from 75 to 95 percent. Gray squirrels are important in distributing the seeds, and a diminishing squirrel population may have adverse effects on dispersal.

Seed production is extremely variable. Some years a large number of acorns are produced (2,000 or more on a tree 24 inches in diameter); but good years do not occur with regularity, and several years may pass without any crop at all.

Seedling growth is interrupted by cold weather, but is resumed in spring. The root system has a prodigious development the first season: a seedling 3 or 4 inches high may have a taproot  $\frac{1}{4}$  to  $\frac{1}{2}$  inch in diameter and more than a foot long.

Young white oak trees of pole size sprout vigorously from stumps or when damaged by fire. Stump sprouts in general result in trees about as good as those from seed.

White oak grows in a wide range of soils, particularly podzolic, both glaciated and unglaciated.

Growth is not particularly rapid, but is generally faster than that of hickories and almost as fast as that of black or red oak. Like many slow-growing trees, it attains a

considerable age; and individuals 600 years old have been found. Clarkson (1964) reported the cutting of a tree in 1913 in Tucker County, West Virginia, measuring 13 feet in diameter 16 feet from the base. The famous Mingo white oak, in Mingo County, West Virginia, was 9 feet 10 inches in diameter at the base and 145 feet tall when cut in 1938 (Strausbaugh and Core 1953). The largest standing tree at present known in the United States is 150 feet tall and 8 feet in diameter.

White oak is intermediate in tolerance, being most tolerant in youth and becoming less tolerant as the tree becomes larger. It tends to become dominant in the stand, partly because of its tolerance and partly because of its longevity. Natural pruning is good in heavily stocked stands, but in the open the tree has a short bole and a wide-spreading crown.

Acorns of white oak were used for food by the Indians, who boiled them in water to remove tannin (Core 1967).

### **CHESTNUT OAK** (*Quercus prinus* L.)

Chestnut oak has a limited geographic range as compared to the other eastern upland commercial species. It is typically a dry-site oak and does better than most other species on dry, sandy, or gravelly soils. It occurs up to elevations of 4,500 feet in the Appalachians. Maximum size, however, is attained in well-drained coves.

Chestnut oak flowers from early April to early May. Freezing temperatures at the time of flowering may greatly reduce acorn production. Good seed production may occur no more than once in a 5-year period.

The acorns mature in the first season and germinate soon after falling in September or October. Litter depth appears to be the most important single factor affecting germination and survival. Some shade on the seedbed appears to be favorable. Growth is relatively slow: in West Virginia the site index ratio for chestnut oak is 0.98, and for white oak 0.95, compared with 1.0 for northern red oak on the same site (Trimble and Weitzman 1956). Chestnut oak matures normally at a height of 60 to 80 feet and a

diameter of 20 to 30 inches. Maximum size is a height of 100 feet and a diameter of 7 feet.

Chestnut oak is a vigorous and prolific sprouter, and in some areas of the southern Appalachians 75 percent of all reproduction is of sprout origin. As with other oaks, however, the vigor of the sprouts decreases with the age of the stump, and decay is more frequent in sprouts from large stumps.

In tolerance chestnut oak is intermediate. In forest stands the trunk is relatively free of branches and it has excellent form on good sites. At high elevations or on poor sites the form is often gnarled and twisted.

In the mountainous region of western North Carolina chestnut oak contributes a greater volume of sawtimber than any other tree (McCormack 1956). Yield is about 7,000 board feet per acre for 80-year-old trees.

The bark on old trees is very deeply and coarsely furrowed, more so than on any of the other upland species.

### **NORTHERN RED OAK** (*Quercus rubra* L.)

Northern red oak, the largest of the eastern upland oaks, extends from New Brunswick, southern Ontario, and Minnesota south to Alabama and Georgia. It is among the most important of the northern hardwoods and extends much farther north than any of the other upland oaks. Mean annual temperature varies from 40°F. in the northern part of the range to 60°F. in the southern part.

Within this range the species is most frequently found on northern and eastern aspects, in coves, and on middle and lower slopes. The best sites are characterized by fine-textured soil and a topography that favors a high water table. Soil types range from clay to loamy and from deep stone-free soil to shallow rocky soil.

The flowers develop about the time the leaves unfold in April and May. The acorn requires two seasons to mature and ripens in September and October. The trees begin to fruit when about 25 years old, and good seed crops are produced every 2 to 5 years.

The acorns germinate in the spring, after dormancy has been broken by overwintering in the leaf litter. Nearly all acorns left on top of the litter are destroyed by rodents. Available moisture is the critical factor in early survival and growth of the seedlings. Vigorous and rapid taproot development follows germination. After the taproot develops, the seedlings will withstand more drought.

In tolerance northern red oak is intermediate. It is less tolerant than white oak but more tolerant than black and scarlet oaks. Regeneration of stands from seedlings is best where the herbaceous growth is not too dense (*Carvell and Tryon 1959*).

Northern red oak averages 70 to 90 feet in height when mature, and 2 to 3 feet in diameter. Maximum size is 160 feet in height and 8 feet in diameter.

Young northern red oak trees sprout vigorously from stumps or when killed by fire. As many as 81 percent of the stumps in a given area may sprout. Stumps as large as 22 inches in diameter develop sprouts (*Roth and Hepting 1943*). Many second-growth stands are of sprout origin, and the resulting trunks are about as good as those from seedlings. Sprouts arising at or below ground level are less apt to decay than those arising higher. In a West Virginia study over 8,000 stems were found per acre, 20 percent being red oak (*Tryon and Carvell 1958*).

Yields of 80-year-old red oak stands range from 2,000 cubic feet per acre to 5,300 cubic feet per acre (*Fowells 1965*).

### **BLACK OAK** **(*Quercus velutina* Lam.)**

Black oak, one of the commonest of the upland oaks, occurs in most upland forest types from southern New England to northern Florida, and west to the margins of the Great Plains. It is found in the Atlantic and Gulf Coastal Plains. Mean annual temperature in this region ranges from 45°F. to 68°F., and precipitation varies from 80 inches in the southern Appalachians to less than 30 inches in Nebraska.

Black oak is usually found on upper

slopes and on dry, sandy, or rocky ridges. In glaciated areas it is found on heavy clay hillsides. In the southern Appalachians it occurs up to 4,000 feet and is an important tree in the foothills. It grows on drier sites than white oak and northern red oak. In the Ozarks it tends to replace shortleaf pine in cutover areas on upper slopes and ridges. The largest trees are found in the rich soils of the lower Ohio River Valley. Black oak occurs on all aspects and slope positions, although near the limits of its range its distribution may be restricted by site.

Flowers appear in April and May, when the leaves are half-grown. The acorns mature in two seasons, ripening in September or October, dropping in November or December. Good crops of acorns may be expected every 2 or 3 years; the number of mature acorns per tree is generally higher than for other species. The trees begin to produce seeds at about 20 years of age, and optimum production is between 40 and 75 years of age.

Acorn germination is favored by a light covering of leaf litter during the winter. The primary root develops vigorously after germination, and young trees characteristically develop long taproots, which is probably the reason why they survive on dry sites.

The seedlings cannot survive under a dense canopy. For this reason black oak frequently does not occur on the better sites, where competition is greater. Because of its tolerance, black oak persists in a mixed stand only when its crown is in the upper canopy.

In the Midwest most second-growth stands are of sprout origin. Small trees sprout prolifically after cutting or after the tops have been killed by fire.

Black oak is relatively short-lived, living about 150 or 200 years. It grows more rapidly than white oak, chestnut oak, and scarlet oak, but more slowly than northern red oak (*Trimble 1960*).

Timber yield throughout much of the range is only about 250 board feet per tree, although exceptional trees may yield 800 board feet. Maximum height is reported as 150 feet and maximum diameter as 7 feet.

**SCARLET OAK**  
(*Quercus coccinea Muenchh.*)

The range of scarlet oak is smaller than that of most of the other upland oaks, but the tree is found to some extent in all States east of the Mississippi except Wisconsin and Florida. West of the Mississippi it occurs only in the Ozarks. It is frequently planted as an ornamental tree and has especially vivid autumnal coloration.

Scarlet oak is a climax tree on dry soils, commonly found on average to poor soils of ridges and upper or middle slopes. It occurs up to about 5,000 feet in the southern Appalachians.

Flowers appear in April and May, and two growing seasons are required for the acorns to mature. Seed production is irregular; however, a good crop may be expected at least once every 4 or 5 years.

A light cover of forest litter is helpful in germination of the seed. The acorns are a choice food for gray squirrels, chipmunks, and mice, which destroy many seeds. However, these rodents also help in the distribution of the seeds.

Stump sprouts are vigorous, and scarlet oak stumps appear to produce sprouts at greater ages and at larger sizes than other oaks. However, sprouts from larger stumps are often subject to butt rot (*Roth and Sleeth 1939*).

Scarlet oak is found on a wide variety of soils, most frequently on gray-brown podzolic soils in the North and on red or yellow podzolic soils in the South.

Scarlet oak is one of the most intolerant of eastern oaks. It is seldom found in a suppressed position in a stand, indicating that it cannot survive when overtopped. It almost always exists as a dominant tree and maintains its position because of its rapid growth rate and its ability to withstand drought.

This oak is a medium-sized tree, normally maturing when 60 to 80 feet in height and 2 to 3 feet in diameter. It grows rapidly and matures early. In some areas it ranks next to yellow-poplar in rate of increase in diameter; in others it is exceeded only by yellow-poplar and red oak. Maximum size is reported as 102 feet in height and 5 feet in diameter.

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