Quercus coccinea Muenchh. Scarlet Oak

Fagaceae Beech family

Paul S. Johnson

Scarlet oak *(Quercus coccinea)*, also called black oak, red oak, or Spanish oak, is best known for its brilliant autumn color. It is a large rapid-growing tree of the Eastern United States found on a variety of soils in mixed forests, especially light sandy and gravelly upland ridges and slopes. Best development is in the Ohio River Basin. In commerce, the lumber is mixed with that of other red oaks. Scarlet oak is a popular shade tree and has been widely planted in the United States and Europe.

Habitat

Native Range

Scarlet oak (fig. 1) is found from southwestern Maine west to New York, Ohio, southern Michigan, and Indiana; south to southern Illinois, southeastern Missouri, and central Mississippi; east to southern Alabama and southwestern Georgia; and north along the western edge of the Coastal Plain to Virginia.

Climate

The range of scarlet oak is within the humid region. Average annual precipitation ranges from 760 mm (30 in) along the western edge of the region to 1400 mm (55 in) in the southeast and at the higher elevations. Mean annual temperatures and growing season lengths range from about 10" C (50" F) and 120 days in New England to 18" C (65" F) and 240 days in Alabama, Georgia, and South Carolina. Actual temperatures range from a minimum of -33" C (– 28" F) in the north to a maximum near 41" C (105" F) in the south.

Soils and Topography

Scarlet oak is found on a wide variety of soils. The soil groups with which it is most frequently associated in the northern portion of its range include Fragiudalfs, Hapludalfs, and Paleudalfs of the order Alfisols (much of these formerly classified as gray-brown podzolic soils). In the northeastern portion of the species range, the predominant soil group is the Dystrochrept of the order Inceptisols (which includes soils formerly classified as brown podzolic). In the south, the species range lies within the area of soil groups that include Fragiudults, Hapludults, and Paleudults of the order Ultisols (much of these formerly classified as red-yellow podzolic soils).

The site index of scarlet oak at base age 50 years ranges from 11.3 to 27.7 m (37 to 91 ft) in the Missouri Ozarks *(4,15)*. In the southern Appalachians, it regenerates and competes best on middle to upper slopes of southern exposure *(17)*. However, site index increases with increasing depth of the A horizon, decreasing amounts of sand in the A horizon, and lower position on the slope. In the northern Appalachians, position on the slope, slope gradient, aspect, and soil depth to bedrock are also important site factors (4).

Although its successional position has not been defined, scarlet oak is probably a climax tree on dry soils. Because of its hardiness, it can be planted on a wide variety of soils.

Maximum elevation for scarlet oak is about 1520 m (5,000 ft) in the southern Appalachians; it is common at elevations less than 910 m (3,000 ft).

Associated Forest Cover

Scarlet oak is recognized as an important component of 14 forest cover types in North America (8). It is a major component of two variants of Chestnut Oak (Society of American Foresters Type 44). The chestnut oak-scarlet oak variant is found on upper slopes and ridge tops in the central Appalachians; the chestnut oak-black oak-scarlet oak variant is common in the Southeast. It is also a major component of three variants of White Oak-Black Oak–Northern Red Oak (Type 52): black oak-scarlet oak, black oak-scarlet oak-chestnut oak, and scarlet oak–chestnut oak. Nearly pure stands of scarlet oak grow in areas of the Ozark Plateau in Missouri.

Other forest types that include scarlet oak as an associate are Northern Pin Oak (Type 14), Post Oak–Blackjack Oak (Type 40), Black Oak (Type 110), Bear Oak (Type 43), White Oak (Type 53), Shortleaf Pine–Oak (Type 76), Loblolly Pine-Hardwood (Type 82), Pitch Pine (Type 45), Shortleaf Pine (Type 75), Virginia Pine (Type 79), Virginia Pine-Oak (Type 78), and White Pine-Chestnut Oak (Type 51).

Common less important trees and shrubs associated with scarlet oak include flowering dogwood *(Cornus florida)*, mountain-laurel *(Kalmia latifolia)*, sourwood *(Oxydendrum arboreum)*, and vacciniums *(Vaccinium* spp.).

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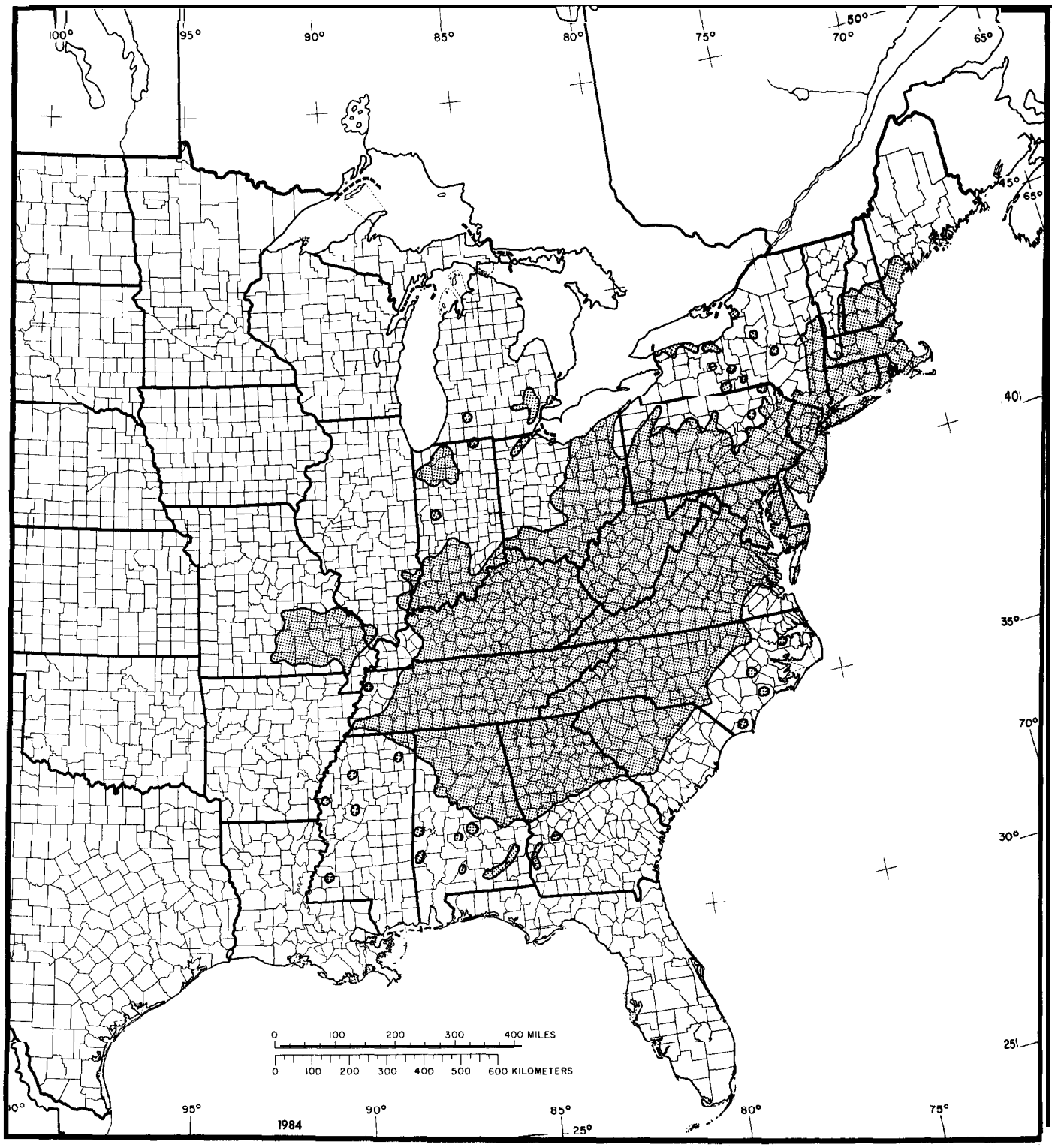

Figure *1-The native range of scarlet oak.*

Life History

Reproduction and Early Growth

Flowering and Fruiting-Scarlet oak is monoecious. It flowers in April or May, depending on latitude, elevation, and weather. Two growing seasons are required for the acorns to mature *(20)*.

Seed Production and Dissemination-Minimum seed-bearing age is 20 years, but maximum production does not occur until after 50 years of age. Seed production increases with tree size up to a diameter of 51 cm (20 in), then levels off. On the average, good seed crops occur every 3 to 5 years, although actual seed production may be irregular and unpredictable from year to year. In Missouri, scarlet oak acorn crops tend to be more variable than those of black oak ***(Quercus velutina),*** white oak *(Q. alba)*, post oak *(Q. stellata)*, and blackjack oak *(Q. marilandica) (4,5)*.

Maximum annual production of mature scarlet oak acorns in Missouri for a 4-year period was about 25 acorns per square meter (2 or 3/ft^2) of crown area *(18)*. In contrast, maximum annual production of black oak and white oak acorns was 70 to 75/m^2 (about 7/ft^2) during the same period. In the Southeast, scarlet oak acorn production has averaged 14.6 kg/m^2 (3.0 lb/ft^2) of basal area of scarlet red oak trees for a 12-year period (2). This production rate was about 25 percent of northern red oak *(Quercus rubra)* and about 36 percent of white oak during the same period; however, scarlet oak acorn production exceeded that of black oak and chestnut oak *(Q. prinus)*.

More than 80 percent of mature scarlet oak acorns may be destroyed by insects. Most insect damage occurs after acorn fall. The most important insect pests are nut weevils *(Curculio* spp.), moth larvae (Lepidoptera), and cynipid gall wasps (Cynipidae) *(18)*. The proportion of uninfested acorns is usually highest in years of greatest seed production.

Scarlet oak acorns are a choice food for eastern gray squirrels, chipmunks, mice, wild turkey, deer, and birds, especially blue jays and red-headed woodpeckers *(4)*. One-third to one-half of acorn losses have been attributed to removal by birds and squirrels while the acorns were still on the tree.

Seedling Development-A light covering of forest litter is beneficial to the germination of scarlet oak acorns; no litter or a deep litter is less favorable. A moderately open overstory canopy provides a more favorable environment for acorn germination than does a completely closed or very open canopy (4). Germination is hypogeal.

Shoots of scarlet oak seedlings commonly die back and resprout, thus forming seedling sprouts; resprouting occurs from dormant buds at or above the root collar. As a result of recurrent shoot dieback, root systems of scarlet oaks may be many years older than shoots. The potential rate of annual height growth of this reproduction increases with increasing basal diameter of sprouts *(23)*. Young stump sprouts may produce up to three flushes of shoot growth per growing season *(6)*. However, individual flush lengths get progressively shorter as the season progresses. Despite the initial rapid height growth of scarlet oak stump sprouts, a comparison of site index curves for sprouts with conventional curves indicated that the height growth of sprouts falls off rapidly after 20 years *(26)*.

A two-cut shelterwood method has been recommended to regenerate scarlet oaks with the first cut made to provide a favorable germination environment (4). The second cut is made to release the advanced regeneration as soon as sufficient numbers of stems are large enough to successfully compete with the other vegetation that will develop when the remaining overstory is removed (24).

Vegetative Reproduction-Scarlet oak stumps produce sprouts at greater ages and larger sizes than most other oaks *(4)*. They also produce a larger number of sprouts per stump and these sprouts grow faster than those of most associated oaks, hickories *(Carya* spp.), and red maple *(Acer rubrum)* during the first 5 years *(25)*. However, the percent of stumps that sprout decreases from near 100 percent for trees 10 cm (4 in) d.b.h. and smaller to about 18 percent for trees 61 cm (24 in) d.b.h. ***(11).***

In a study of scarlet oak sprouts in the Appalachians, 28 percent had butt rot, and sprouts from large stumps were more subject to butt rot than sprouts from small stumps (22). As the sprouts grow older, the rot spreads and may weaken the trees to a point where they break off during high winds. Because of poor natural pruning, only one-third of scarlet oak crop trees originating from sprouts produce stems with desirable bole quality, even on good sites, i.e., oak site index 23 m (75 ft) (27). However, in coppice stands, thinning sprout clumps to one stem can increase growth and survival of the remaining stem ***(14).***

Sapling and Pole Stages to Maturity

Growth and Yield-Scarlet oak (figs. 2, 3) is a medium-sized tree, normally maturing when 18 to 24

Figure *2-An excellent group of 54-year-old scarlet oaks in South Carolina.*

m (60 to 80 ft) tall and 61 to 91 cm (24 to 36 in) d.b.h. Maximum size is about 30 m (100 ft) in height and 122 cm (48 in) in d.b.h. The tree grows rapidly and matures early. Economic maturity is reached at 46 to 58 cm (18 to 23 in) d.b.h., depending on vigor class *(4)*.

In diameter growth, scarlet oak ranks ahead or equal to that of associated oaks. Among 11 species compared in pole-size stands in the Central States, average lo-year diameter growth for scarlet oaks was exceeded only by yellow-poplar *(Liriodendron tulipifera)* and black walnut *(Juglans nigra) (9)*. However, on poor sites, scarlet oak probably grows more rapidly than any of its associates *(4)*. Yields of fully stocked unthinned oak stands in which scarlet oak is present range at age 80 from about 75.6 m^3/ha (5,400 fbm/acre) for site index 55 to 175.0 m^3/ha (12,500 fbm/acre) for site index 75 *(10)*. Thinning scarlet oak stands can greatly increase growth and quality of individual trees *(7,12)*.

Rooting Habit-Scarlet oak seedlings develop a strong taproot with relatively few lateral roots. Difficulties in transplanting this species may be related to its coarse root system plus its relatively slow rate of root regeneration *(16)*.

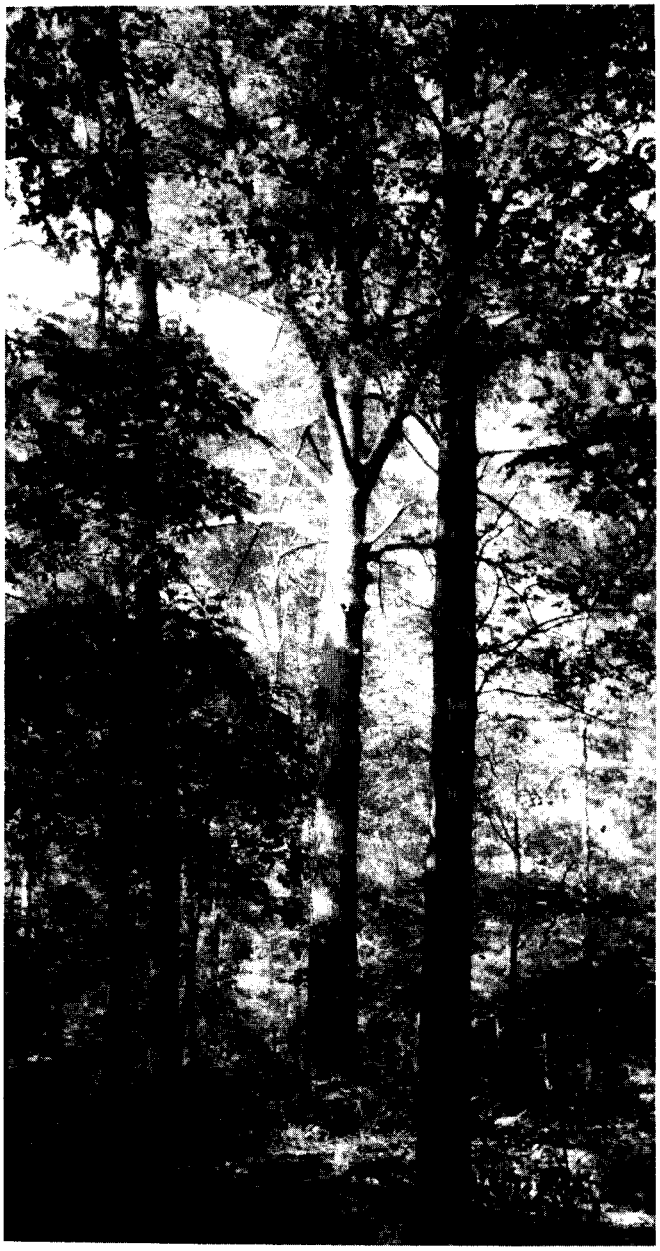

Figure *3-A mature* scarlet *oak in the Mark* Twain *National Forest, MO.*

Reaction to Competition-Scarlet oak is classed as very intolerant of shade. Except for reproduction under older stands, it is usually found only as a dominant or codominant (4). Its absence in suppressed or intermediate positions is indicative of its

intolerance. It probably maintains its dominance on dry sites because of its rapid growth and drought tolerance, and because of light conditions that are adequate for the establishment and development of reproduction *(4,21)*.

When site index is equal, scarlet oak tends to be better represented in forests with a fire history than in forests with little or no evidence of past burning (3). Its better representation on burned sites may be related to its vigorous sprouting ability after burning, together with the elimination of more fire-sensitive competitors.

Damaging Agents-Because of its thin bark, scarlet oak is very susceptible to fire damage. If not killed outright, the tree is usually injured so that sap or heart rots enter *(4)*. This weakness, coupled with a dry environment, helps explain the high mortality or severe damage to trees even from light ground fires. Nevertheless, basal sprouting from fire-killed scarlet oaks may be prolific.

Heart rots of scarlet oak can enter the bole through branch stubs even at an early age and cause severe damage. Heart rots are especially common in stump sprouts that originate high on the stump *(4)*. In one study, decay in scarlet oak sprouts that originated at or below ground line was only 9 percent, whereas decay in sprouts originating 2.5 cm (1 in) or more above ground was 44 percent (22). The fungus *Stereum gausapatum,* which is transmitted from stump to sprout, was the most common cause of decay.

Scarlet oak is also susceptible to oak wilt *(Ceratocystis fagacearum)*. Trees attacked by this fungus may die within a month after the first symptoms appear. This oak is also subject to cankers of *Nectria* spp. and *Strummella coryneoidea.* These diseases are especially severe from Virginia northward (4).

The major insect defoliators in scarlet oak include the oak leaftier *(Croesia semipurpurana),* fall canker-worm *(Alsophila pometaria),* forest tent caterpillar *(Malacosoma disstria),* gypsy moth *(Lymantria dispar),* and orangestriped oakworm *(Anisota senatoria) (19)*. Coupled with defoliation by spring frosts, repeated defoliation by these insects either individually or in combination is thought to be the primary cause of "decline" and mortality of scarlet oak and other oaks in the red oak group in Pennsylvania. Similarly, in the Missouri Ozarks, scarlet oak decline has been linked to a complex of factors including insects, disease, drought, and soil-site relations (13).

The walkingstick *(Diapheromera femorata)* may severely defoliate scarlet oak, particularly in the northern portion of the scarlet oak range. The twolined chestnut borer *(Agrilus bilineatus)* is a secondary pest of scarlet and other oaks following drought, fire, frost damage, or defoliation by other insects. Larvae of carpenterworms *(Prionoxystus* sp.) can damage scarlet oak by tunneling into heartwood and sapwood. They prefer open grown trees or trees growing on poor sites. Ambrosia beetles *(Platypus* sp. and *Xyleborus* sp.) and the oak timberworm *(Arrhenodes minutus)* can invade and damage freshly cut or wounded trees *(4)*. The red oak borer *(Enaphalodes rufulus)* breeds in trunks of living trees greater than 5 cm (2 in) d.b.h. Larvae bore into phloem and cause serious defect and degrade; ants and fungi may then enter wounds and cause further injury *(1)*. The black carpenter ant *(Camponotus pennsylvanicus)* sometimes nests in standing trees. Ants may enter the tree through stem cracks, scars, and holes and may extend their galleries into sound wood *(1)*. The gouty oak gall wasp *(Callirhytis quercuepunctata)* can produce galls on twigs and smaller limbs of scarlet oak, and heavy infestations may kill the entire tree. Also, the large oak-apple gall wasp *(Amphibolips confluenta)* may cause gall on the leaves or leaf petioles of scarlet oak *(1)*.

Special Uses

In addition to its value as a timber and wildlife species, scarlet oak is widely planted as an ornamental. Its brilliant red autumn color, open crown texture, and rapid growth make it a desirable tree for yard, street, and park.

Genetics

Scarlet oak hybridizes with black oak *(Quercus uelutina),* producing Q. *x fontana* Laughlin, and with bear oak *(Quercus ilicifolia),* producing *Q. x robbinsii* Trel.; it also hybridizes with pin oak *(Q. palustris)*.

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