STRUCTURAL DEVELOPMENT OF TREES[1]

by Richard W. Harris

Abstract: To develop a tree that is structurally strong, it should be trained to exploit the better elements of its branching pattern and growth characteristics. A tree develops a well-tapered trunk, better able to distribute stress uniformly along its length, if it is grown with more than one-half of its foliage on branches that originate from the lower two-thirds of the trunk. Branches are attached to the trunk more securely if they are well-spaced vertically along the trunk, are thinner than the trunk where they arise, and have wide angles of attachment. An unstaked tree can move in the wind, resulting in a shorter tree, with larger trunk caliper, greater taper, and a larger root system better able to withstand the elements without support. Stakes and ties detract from tree appearance and can seriously injure the trunk. The angle at which a main branch grows can be directed by pruning to a more upright shoot or by leaving a spreading branch to be more horizontal.

Proper training of young trees is necessary to develop their inherent structural strength and ability to withstand the elements. The training will necessarily exploit the natural branching habit and tree form of the species.

Tree Form

The form of trees is determined by: 1) the locations of leaf and flower buds (terminal or lateral); 2) the pattern of bud break along the trunk branches; and 3) the differential elongation of buds and branches. In most conifers and a few angiosperms, the main stem or leader outgrows and subdues the lateral branches beneath, giving rise to a cone-shaped crown with a central trunk. This is called an excurrent branching habit. In contrast, most angiosperm trees and shrubs have a more round-headed, spreading habit, with no main leader to the top of the plant. This habit is called decurrent, deliquescent, or diffuse. The lateral branches of such plants grow almost as fast as the terminal shoot or may even outgrow it, so that in a year or more the central leader becomes lost among the other branches that develop.

The growth habit that a tree will develop can be determined soon after it begins seedling growth. If the terminal growing point has weak apical dominance, with a lateral growing from almost every node on current growth, the tree will have an excurrent growth habit,e.g., pine, pin oak, and liquidambar (1). On the other hand, if the terminal growing point has strong apical dominance, with few or no laterals growing on current growth, the tree will develop a decurrent growth habit, e.g., most oaks, elms, and walnut. These sequences are just the opposite of what many people thought to be the situation.

Leader and Branch Development

A young tree with an excurrent growth habit will develop a main leader with relatively small lateral branches. The only pruning needed might be to keep a lateral from competing with the leader or to remove lower branches if desired.

A tree with decurrent growth, however, may need considerable pruning to keep the leader dominant until the main branches can be selected at the desired height and spacing (3). After the first year, lateral shoots often outgrow the leader. Therefore, if laterals grow on the trunk lower than permanent branches are wanted, they should be pinched back during the growing season to keep dominant the potential permanent branches and particularly the leader.

As the growing point of the leader grows beyond the height where the lowest permanent branch is wanted, pinch out the terminal inch or so of the tip. In about two weeks if the tree is vigorous, two or more shoots will begin growth below the pinch. When they are 6 to 8 inches long, select the most vigorous upright shoot as the leader, and select a lateral below the new leader for the first permanent branch. Prune off any growth terminal to the leader and pinch other shoots back half way. As the leader continues growth, terminal pinching can be repeated to select additional main branches growing at the desired height and direction. With vigorous trees, as many as three permanent branches have been stimulated to grow in one season instead of ending up with a long, unbranched leader with no

[1]Presented at the annual conference of the International Society of Arboriculture in San Diego, California in August 1979.

laterals.

Another approach is to visit the trees regularly during the first few growing seasons. Pinch back laterals growing where scaffold branches are not wanted. Let vigorous laterals in desired positions grow, though not more vigorously than the leader. These branches will originate and be selected a year later than with the first method described.

If main scaffolds are not chosen until the first winter after they have grown, they may not be where wanted and/or too close together. They also may have outgrown the leader, so that it may be difficult to achieve the desired vertical spacing of new branches.

In developing the leader and scafford branches, leave slower-growing shoots along the trunk to shade and nourish it. Keep these shoots cut back during the growing season to within a foot of the trunk. In winter, remove the largest of these temporary growths, leaving the less vigorous ones. When the trunk is 4 to 5 inches in caliper, the temporary growths can be thinned out over the next two or three years.

For scaffold branches, select vigorous branches with wide angles of attachment. Narrow angles of branch attachments with bark ridged up in the crotch are stronger than those with bark embedded in the crotch. A branch with embedded bark in its attachment to the trunk should be removed as soon as noticed. Usually another shoot will grow from the same node or one nearby. These later-growing buds usually form branches of smaller size with wider angles of attachment.

Even though vigorous branches should be chosen, the caliper of each should ideally be less than 75 percent of that of the trunk where the branch arises. Scaffold branches should be spaced vertically along and around the trunk. Vertical spacing is more important in large growing trees than small ones. For large trees, vertical spacing should be at least 18 inches to ensure reasonable separation at maturity. Trees with two or more limbs arising close together may crowd or choke out the leader when young and create a zone of weakness when mature.

Trunk Free to Move

A tree should be grown without rigid trunk support. Young trees need to be protected from vandalism and other physical damage, but the more freedom a tree has during its development, the better it will be able to withstand the elements (5,6). Such a tree will grow less in height, grow more in caliper, develop more taper, form a larger root system, and have more uniform xylem tissue than a tree that is rigidly staked. Staking can cause other problems, too. A staked tree can lose its ability to stand alone (2), will have stress on the trunk concentrated at the top tie (4), is often injured by rubbing against the stake or being girdled by the tie(s), and can be quite unattractive.

Stress Distribution

A tree that has grown or been trained properly will have branches and foliage that are well distributed for better withstanding storms and other hazards. Leiser and Kemper (4) determined that an unstaked tree can best withstand wind stress and continue balanced growth if half or more of its foliage is on branches originating from the lower two-thirds of the trunk. Stress on such a tree will be evenly distributed along the lower 60% of its trunk, with much less stress beyond. This tree will have the growth characteristics attributed to unstaked trees.

Directing Growth

Pruning can help guide the growth of developing limbs. Vertically growing limbs are usually more vigorous than horizontal limbs. To direct a branch to more upright growth it may be necessary to prune it back to an upright lateral or bud. A tree will become wider if tall upright branches that begin to bend outward are not pruned. Laterals will grow from near the top of the curving branch. These laterals will be further from the center of the tree than if the original upright branch were headed to an outward-facing bud. Upright branches can be forced to grow outward also by putting a stick or straight shoot between the trunk and the branch to be spread. Be sure the branch is strongly attached or it may split out. The spreader can be removed in a year or two.

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ABSTRACTS

VAN DE WERKEN, HENDRIK. 1979. **How shade tree research can help you increase the growth rate of your trees.** Landscape Industry 24(4): 26-28.

The Tennessee Agricultural Experiment Station, University of Tennessee, Knoxville, started shade tree nutrition research in 1960 and a shade tree transplanting study in 1964. In 1969 research on shade tree grove development was begun. In 1973 a project was developed to investigate shade tree cultivar performance and their response to slow and fast release fertilizers and methods of fertilizer application. Trees which received only additional nitrogen each year for 10 years were 20 to 40 percent taller than those not fertilized. The trunk volume and crown canopy area increases of nitrogen fertilized trees were relatively greater than height increase. Laboratory tests also indicated that the wood quality of the trunk of the fast-growing fertilized trees was not affected, i.e., there was no detectable change in either wood density or wood fiber length. Based upon these results, it may be concluded that broadcast application of nitrogen alone, to shade trees in lawns, greatly accelerated growth and resulted in taller trees with relatively heavier trunks and broader crowns. In general, nitrogen fertilization, mulching, and close spacing of shade trees increased both trunk size and height without affecting proportionate development and wood quality.

BANKER, H.J. 1979. **A national arbor day — the solution to indifference?** Am. Nurseryman 149(8): 58, 60, 62, 66.

We need to take a long, hard look at the price progress has placed on the future of America's trees. Although Arbor Day has been with us for more than 100 years, its influence on the public has been quite varied, ranging from outspoken enthusiasm to actual disappointment and failure. However, the establishment of Arbor Day did initiate many shade tree laws and ordinances over a wide area of the U.S. These laws were enacted to preserve and protect our nation's trees. It was Ed Scanlon's firm belief that establishment of a national Arbor Day — the last Friday in April — would be the strong force that would generate the ideas and action to promote reforms of our outmoded practices and to protect and conserve America's trees. He also felt that massive public education, via publicity on a uniform Arbor Day date, would reawaken their needed interest in the value of trees.