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PRUNING FUNDAMENTALS[1]

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Abstract: To more effectively prune trees certain aspects of plant growth are presented as well as the more commonly known responses to pruning. Trees with strong apical dominance have few or no laterals on current growth, but their terminals are not able to control growth of lateral buds and shoots in subsequent years. Such trees develop a round-headed (decurrent) form. The opposite is true of plants having weak apical dominance. They have strong apical control leading to a central-leader (excurrent) form.

Pruning is an ancient practice, well understood by most arborists, well described in many books (1, 3, 4, 5, 8), but the principles often are not practiced nor appreciated. The following comments are to provide a basis for understanding tree growth and form, and the fundamentals of pruning so we can better evaluate tree structure and pruning practices. We want to capitalize on the growth habits of trees to accentuate their natural form and to minimize pruning.

Pruning is the removal of parts of a plant, e.g. leaves, shoots, and branches. The picking of blossoms and fruit also could be considered pruning. Pruning not only determines the size and shape of a plant but influences future growth. Plants are pruned to:

1) compensate for root loss at planting;
2) direct the growth of young plants;
3) control the size of plants;
4) influence flowering, fruiting and vigor; and
5) maintain plant health and appearance.

Plant Growth and Form

Understanding certain aspects of plant growth, how growth is influenced and how growth influences plant form can simplify our approach to pruning trees.

The form of woody plants, particularly trees and shrubs, is determined by 1) the location of leaf and flower buds (terminal or lateral), 2) the pattern of bud break along the trunk and branches, and 3) the differential elongation of buds and branches. For example, the absence of lateral buds in most of the arborescent (tree-like) monocots leads to a columnar growth habit in which an unbranched trunk ends in a tuft of leaves, e.g. palms. In most of the conifers and a few angiosperms, the main stem or leader outgrows and subdues the lateral branches beneath giving rise to cone-shaped crowns with a central trunk. This branching habit is called excurrent. 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 or even outgrow the terminal shoot so that in one or more years the central leader is lost among the other branches that develop.

Knowing the form a plant will naturally grow into will aid in better selecting plants for specific landscape uses and simplify training of young plants. Some of the earlier work on herbaceous plants (7) involving the influence of auxins on shoot growth and plant form was erroneously assumed to be true for woody perennial plants (2).

Apical dominance and control. Apical dominance connotes bud inhibition by the active growing terminal bud cluster on a currently

1. Presented at the International Shade Tree Conference Detroit, Michigan in August, 1975.

elongating shoot. Trees with decurrent (spreading) branching habit have been thought to have weak apical dominance in contrast to those of excurrent habit which were thought to have strong apical dominance. Just the opposite has been found to be true (2). Decurrent species such as most oak, elm and maple have strong apical dominance in shoots the season that the shoots are growing. In such species few or no lateral buds develop the year that the shoot on which they occur grows. However, the next year, one or more lateral buds are released. These may develop into branches that outgrow the original leader. So, a species that has shoots with strong apical dominance ends up as a round-headed tree because the leader is not able to subdue and outgrow its laterals that develop in subsequent years. Such a tree is said to have weak apical control.

On the other hand, excurrent species, such as sweet gum, tulip tree and most of the conifers, exhibit weak apical dominance. In such trees, varying numbers of lateral buds grow the same season as the shoot on which they are formed. However, in most cases, the leader is able to keep ahead of the lateral branches resulting in a typical "central leader" or conical form. In these cases, the leader has weak apical dominance but would be considered to have strong apical control.

It may help to visualize the interrelationship between apical dominance and apical control to remember that strong dominance is confined primarily to the current season's shoot growth. The next season, the lateral buds (a few or many) and the terminal bud formed the year before will start growth. The apex of each of these new shoots will have strong dominance over buds on current growth but not on the shoots that are growing below. Some of the new lateral shoots may be so vigorous that they will outgrow the original terminal shoot. This in turn is repeated year after year leading to a round-headed (decurrent) tree.

Strong apical dominance in current shoots leads to lack of dominance of the terminal bud cluster over buds on older wood below. This lack of dominance over buds on older growth is termed "weak apical control." Strong apical dominance of current growth leads to weak apical control of subsequent growth and vice-versa.

Plants do not neatly fit into one growth habit category or the other but range between the extremes which are more easily distinguished and have been discussed above.

Plant vigor influences the expression of apical dominance and control. Vigorous shoots exhibit less apical dominance than those of low vigor on plants of the same species. Therefore, some of the lateral buds on the more vigorous shoots may be released from dominance of the shoot tip. Such a tree will have a more excurrent growth habit. In contrast, as plants mature or grow under conditions of stress or low fertility, they become less vigorous. Shoots on such tress increase in apical dominance which then leads to a loss of apical control, giving rise to a more round-headed plant. Therefore, a tree that has an excurrent growth habit while young, may become round-headed as it reaches maturity.

Removal of the terminal bud cluster will not change the excurrent or decurrent habit of an individual tree. Only by repeated pruning can excurrent forms be changed into decurrent-like forms or vice-versa. It is true, however, that removal of the terminal bud cluster on a shoot with strong apical dominance will release one or more buds immediately below the point of removal. The buds further below the cut will be kept from growing. This is particularly true the next season, if a dormant shoot has been cut back before growth begins. The new shoots are clustered just below the cut. On the other hand, if a shoot with no lateral branches is not cut back, more buds will start growth next season and they usually will be more evenly distributed along the shoot.

The extent of inhibition of lateral buds apparently is determined by a balance of growth factors. These relationships are complex and vary with species. As yet no single explanation is available.

Species which have terminal flowers or flower inflorescences are normally round-headed

since growth following blossoming comes from lateral buds below the flowering terminal. Usually more than one bud will break, speeding the process leading to round-headedness. Competition between the two or more shoots also reduces the growth of each, leading to a more compact plant.

With this information in mind, the form or shape of a tree can be fairly accurately predicted by observing the current season's growth.

Angle of Branch Attachments

The angle at which lateral branches are attached to the trunk of a tree can greatly influence its form, as well as the strength of the tree structure. Narrow branch angles form weak unions with the main trunk. Moreover, upright branches are more vigorous than those growing more horizontally and could outgrow or compete with the main leader.

Vigorous leaders tend to be more upright and have laterals with wider angles of attachment than those of lower vigor. However, angle of branch attachment is primarily influenced by the genetic make-up of the plant. Certain species or cultivars are noted for their narrow angles of branch attachments, e.g. Modesto ash.

The angles of attachment of branches forming on apple tree whips increase from the terminal towards the base (9). It is known that branch angles will be more acute if buds have been removed on the stem above the bud in question or the bark has been scored, cut to the cambium, above the bud. Both of these practices must influence the level or balance of growth substances at the node.

Removing a lateral with a sharp angle of attachment from a young leader may force accessary buds to grow from the same node. The angles of attachment of the shoots from these buds usually are greater than those of the original shoot. This information can be put to good use in the training of young trees to help develop stronger attachments of laterals.

Trunk Development

The development of a strong, upright trunk is desired in most landscape trees for street, patio, and park use. Understanding factors which influence trunk development can help you train trees with a desired structure. Such understanding also will help in developing multi-stemmed trees or those having a more sculptured form.

Lateral branches along the trunk encourage caliper growth of the trunk although height will be less if the laterals are not kept shortened. Horizontally growing laterals usually are slow growing and easier to keep in bounds. Vigorous shoots are more upright than those of low vigor and usually form more laterals.

Leiser and Kemper (6) have demonstrated by computer and actual trunk samples that stress is more evenly distributed along a tapered trunk than one without taper. To help achieve trunk taper as well as more uniformly distribute wind stress along the trunk, they concluded that not more than 1/2 of a tree's foliage should be in the upper 1/3 of the tree. Or conversely, at least 1/2 or more of the foliage should be in the lower 2/3 of the tree. This is in marked contrast to the way many young trees are grown in the nursery and the landscape.

Influence of Pruning

With some appreciation of how plants grow and plant form is influenced, let's turn to plant responses to pruning. The effects of pruning are seemingly contradictory. Pruning *invigorates* a plant and at the same time *dwarfs* it. Mature fruiting plants may be an exception to the latter part of this statement.

Pruning removes leaves and shoots, or buds which will develop into leaves and shoots. After pruning, a plant has fewer growing points (buds or shoot tips) than before but it has essentially the same root system. This has the effect of increasing the water and nutrient supply to the remaining growing points. Shoots will grow more rapidly and later into the season. In this regard, pruning is similar to nitrogen fer-

tilization, the leaves will become larger and greener.

Even though individual shoots on a pruned plant will become longer with greener leaves, the total leaf area invariably will be less than on an unpruned or more lightly-pruned plant. In addition the total leaf area on the more severely-pruned plant will have less leaf area effective for a shorter period of time. Less food will be produced by the pruned plant. Total growth of a shoot or a plant will be less when pruned.

These influences are the key to pruning. They can be used to full advantage in training young trees. In order to encourage a limb or a plant, it should be pruned lightly or not at all. A limb also may be favored by pruning other branches to let more light to the branch to be encouraged. To discourage or slow the growth of a limb or plant, prune it more heavily. The more severe the pruning, the greater will be its invigoration effect as well as its dwarfing influence.

Pruning may not dwarf a mature fruiting plant. Pruning normally removes more potential fruit than leaves. A fixed number of flower buds are left than could develop into fruit, but on most plants the leaf area depends on plant vigor. Fruit has first call on food produced by the leaves thereby reducing shoot and root growth on a fruiting plant. In such cases, pruning not only invigorates the plants so individual shoots are longer but also may increase the total growth of the plant.

Pruning usually will delay the flowering and fruiting of young plants which produce flowers on one-year-old wood, e.g. flowering plum, crab apple and cherry. In order to form flower buds, a plant with this flowering habit needs conditions which favor both adequate nitrogen and food supply early in the growing season. Pruning, and likewise nitrogen fertilization, may favor rapid shoot growth at the expense of flower bud formation. Certain young plants may be delayed in flowering several years by heavy pruning. Others may be little affected.

Pruning Cuts and Responses to Them

Two general types of pruning cuts can be described which differ in the manner in which they are made and in the plant response to them.

Heading back is cutting to a stub, a lateral bud or a branch so small that the new growth comes from a few buds near the cut and is vigorous while the lower buds may remain latent. Vigorous, upright growth results in a compact, unnatural appearing plant with dense shade. In older trees, the new growth from stubs seldom becomes strongly attached and may split out easily.

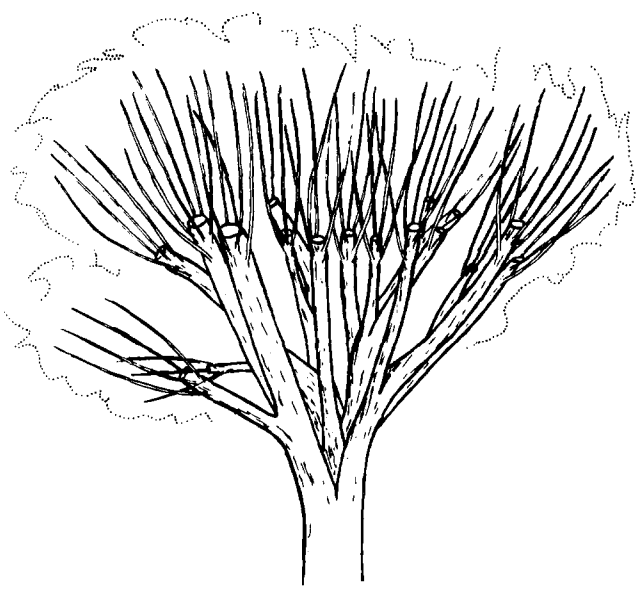

Fig. 1. A headed tree will force many vigorous upright shoots. The tree loses it natural form.

Thinning out or cutting to laterals is the removal of lateral branches at their point of origin or reducing the length of a branch by cutting to a lateral large enough that it tends to assume the terminal role and the new growth is modified accordingly. New growth is not concentrated near the pruning cut but usually is distributed along the entire branch. Thinning-out pruning results in an open, airy, natural appearance with good light penetration.

The size of a plant may be more effectively

controlled by thinning out than by heading back. Thinning to lower growing laterals will result in less growth of individual shoots. Thinning out of equal severity is less invigorating and dwarfing than is heading back.

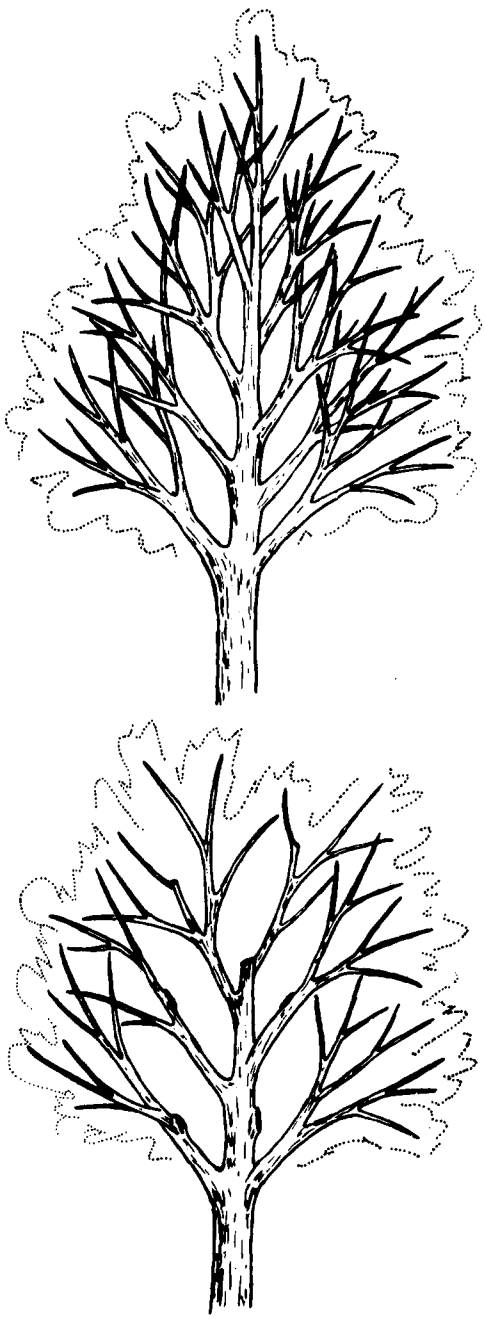

Fig. 2. Thinning reduces the height of and opens up a mature tree(top) retaining the natural appearance and form of the tree(bottom).

There is a place for each type of pruning. However, heading back should be mainly restricted in training to influencing the location of lateral branching; to repressing a branch, with few or no laterals in relation to another; and to encourage more upright growth of spreading branches. Heading back may be used to stimulate flowering of plants which bloom on current-season's growth. It also is practiced in pollarding of such trees as London plane.

Thinning-out pruning should be used on most landscape trees and shrubs except for the situations mentioned above. Thinning-out requires more skill and time to perform than does heading back. However, the trees will be more natural appearing and should not need to be pruned as soon as trees which have been headed back.

Time to Prune

The time of pruning depends on the results desired.

Light pruning can be done anytime. The removal of unwanted growth while it is small will have less dwarfing effect than removing it later and it is easier. Broken, dead, weak or densely shaded branches can be removed with little or no effect on a plant.

To encourage rapid plant development, prune before the period of most rapid growth. For deciduous plants, this would be anytime between leaf fall and the beginning of growth in the spring. Evergreen plants would be pruned just before their period of most rapid growth, in the spring or early summer. With this timing, the most leaves will be active for the longest period of time.

To retard plant growth, prune just as the period of rapid growth is over (mid to late summer), but late enough so as not to encourage new shoot growth. This will reduce the leaf area for the longest time. The pruning will need to be done with care since new growth will not soon cover up the pruning cuts.

To encourage flowering, the time of pruning would depend on the flowering habit of the

plant. Plants which flower on current-season's growth, e.g. crape myrtle, should be pruned before growth begins in the spring. The more severe the pruning, the larger the blossom clusters will be and the longer they will last. These plants usually bloom during the summer.

Plants which flower in the spring from buds on one-year-old wood, e.g. flowering plum and cherry, should be pruned at or immediately after bloom. This timing will provide the greatest amount of bloom which is removed before its developing fruit competes for food with the new shoots. Vigorous shoot growth may be needed for abundant bloom the following year.

To direct the growth of a plant, prune during the growing season as well as the dormant. Shoots growing in desired locations can be encouraged by removing or suppressing shoots in unwanted locations. It is not necessary to remove the entire shoot; it can be retarded by removing the tip 2 to 4 inches.

On older trees, limbs which are too low with heavy foliage or fruit can be readily seen and removed or pruned up. Weak and dead limbs can be easily spotted and removed during the growing season.

Pruning Mature Trees

A few comments on pruning mature trees. All too often this pruning is not done on a regular basis. Only the trees in critical need of pruning are able to be pruned. As a result the trees usually are not given the proper pruning. In many cases, trees are pruned improperly through ignorance.

From the discussion about heading back and thinning out, it should be rather obvious that in most situations mature trees should be pruned by thinning out. A tree can be reduced in height and spread by such pruning. This type is sometimes referred to as "drop crotching," pruning to a lateral large enough to assume the terminal role. Trees pruned in this manner will be more natural appearing and longer lived. The only disadvantage is that even though truck loads of brush may be hauled away from a tree, many people will not realize it has been pruned. This is the ultimate compliment for a job well done. It may, however, be hard to explain. There are more details that could be elaborated; however, if the principles presented are understood, the secret of pruning is yours. Only practice will make it a reality, but you should be in better position to make pruning decisions as well as to appreciate the branching structure of the trees in your landscapes.

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