

# TRUNK DEVELOPMENT OF YOUNG TREES

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Trees were produced in these tests that could stand erect without staking—by eliminating stakes during production, by leaving lateral branches on the trunk, and by spacing plants so their tops were free to move. Even though rigidly staked trees with lower limbs removed grew taller, they developed less trunk caliper, regardless of whether they were lightly or severely pruned. These trees were not able to stand upright when planted out, while the unstaked trees needed little or no support.

**W**ITH THE ADVENT of container production of trees in nurseries, changes in traditional cultural practices have been developed. The changes include closer spacing, removal of lower branches to facilitate watering and spraying, and staking to prevent lodging. As a result, many trees require staking after planting in the landscape. Such staking is costly and can severely injure trunks and limbs unless carefully done and frequently inspected.

In nature, trees usually develop trunks capable of standing erect. The inability of many container-grown trees to stand upright in the landscape was thought to be aggravated by rigid staking during nursery production.

Young tree trunks have been strengthened and leader growth has been retarded by leaving lateral branches on the trunk. The usual California nursery and landscape practice is to remove laterals from the lower trunk. This experiment was designed to study the effects of staking and pruning on trunk development of young trees.

## Nine species

The nine species of trees commonly grown in California used in these tests were: *Eucalyptus sideroxylon* A. Cunn., mulga ironbark; *Fraxinus uhedei* Lingelsh., Shamel ash; *Grevillea robusta* A. Cunn., silkoak; and *Schinus terebinthi-*

*folius* Raddi., Brazilian pepper at ABC Nursery, Gardena; *Betula verrucosa* Ehrh., European white birch, and *Eucalyptus sideroxylon* at Oki Nursery, near Sacramento; *Eucalyptus polyanthemos* Schauer., round-leaf eucalyptus; *Liquidambar styraciflua* L., liquidambar or sweetgum; *Pistachia chinensis* Bunge., Chinese pistache; and *Quercus ilex* L., holly oak; at Saratoga Horticultural Foundation.

The four treatments included: (a) rigid staking with the laterals removed on the lower half of the trunk (conventional nursery practice), (b) rigid staking with the laterals headed to 8 to 10 inches on the lower half of the trunk, (c) no staking with the laterals headed to 8 to 10 inches on the lower half of the trunk, and (d) no staking and no pruning. Heading was to be a relatively soft pinch, removing 2 to 4 inches; frequently, however, more was removed because of the vigorous growth. Eight trees of each species were used per treatment.

Treatments began in early July 1967, just after the trees had been transplanted from 1-gallon cans to 5-gallon or egg cans. The growing media were modifications of "U.C. Type" mixes containing sand, organic matter, etc. Staked trees were tied to 1 x 1 x 60 inch stakes and unstaked trees were tied to short stakes, 4 inches above the soil, until new root growth stabilized them in the larger containers. The containers were set 24 inches on center to allow free movement of the top and for sunlight to penetrate between the plants. Pruning and tying was done every 3 to 4 weeks during the growing season. The leaders of the staked trees were tied every 6 to 8 inches along the stake as they grew. The height to which the laterals were pruned each time was increased so that laterals on the lower half of the trees were either headed or removed.

The influence of the several cultural practices can be separated by comparisons among three pairs of treatments:

(a) staking vs no staking on the lightly pruned (laterals headed) trees; (b) severe (laterals removed) vs light pruning on the staked trees; and (c) light pruning vs no pruning on the unstaked trees.

## Effects of staking

The staked and unstaked, lightly pruned treatments showed that staking markedly increased height, but decreased caliper growth and taper (decrease of caliper with trunk height) of eight of the nine species (table 1 and photo). Staked trees made 25% more height growth, 15% less caliper growth, and had 24% less taper (table 2). A number of the staked trees had greater caliper near the top of the stake than at the base, as did the staked tree in photo. The only exception among the nine species was that staking had little or no influence on growth of Brazilian pepper.

The root systems of the staked trees tended to weigh less than those not staked in five of the seven sets of trees measured, although differences were not significant.

At the end of the growing season, almost all trees that had not been staked stood upright without support, while most of the staked trees did not.

## Pruning, removal, vs. heading

Severely and lightly pruned staked trees showed little difference in height growth, except liquidambar (which grew significantly taller) and holly oak, (which grew significantly less) when severely pruned (table 1). However, lateral removal reduced caliper growth 11% or more in 5 of the 10 comparisons (significantly in silkoak and holly oak), but had little or no effect on the others. Removal of laterals also resulted in 14% or more reduction in taper in 5 of the 10 comparisons. Although Chinese pistache had greater taper when severely pruned, differences were not statistically significant. These variable results may reflect inherent differences among species in



Influence of staking on round leaf eucalyptus for 11 months. (a) Left, tree grown without stake and lower laterals on trunk headed to about 8"; right, tree tied to 1 x 1" stake and lower laterals removed. (b) Right, tree untied from the stake.

TABLE 1. HEIGHT AND CALIPER INCREASES AND TAPER OF 9 SPECIES OF CONTAINER-GROWN TREES SUBJECTED TO DIFFERENTIAL PRUNING AND STAKING FOR 5 MONTHS.\*

Species, location†	Staked		Unstaked	
	Pruning treatment of laterals			
	Removed	Headed	Headed	Unpruned
<i>Betula verrucosa</i> —Oki				
Height increase, cm	101a‡	104a	85a	57b
Caliper increase, mm	7.8a	8.9ab	9.9ab	10.4b
Taper, mm/m	7.8a	8.2a	9.6a	13.2b
<i>Eucalyptus polyanthemos</i> —Saratoga				
Height increase, cm	149a	148a	107b	81b
Caliper increase, mm	9.0a	10.7a	12.7b	14.0b
Taper, mm/m	4.0a	4.1a	6.5b	11.3c
<i>E. sideroxylon</i> —Oki				
Height increase, cm	126a	134a	84b	76b
Caliper increase, mm	6.8a	7.2a	9.8b	12.8b
Taper, mm/m	4.6a	5.7a	8.7b	10.3b
<i>E. sideroxylon</i> —ABC				
Height increase, cm	144a	136a	126a	97b
Caliper increase, mm	7.8a	8.8a	9.6a	12.0b
Taper, mm/m	4.8a	5.7a	7.0a	12.4b
<i>Fraxinus uhedei</i> —ABC				
Height increase, cm	158	159	140	133
Caliper increase, mm	19.3	18.2	20.5	21.2
Taper, mm/m	8.9a	9.1a	13.8b	14.1b
<i>Grevillea robusta</i> —ABC				
Height increase, cm	135a	135a	122b	122b
Caliper increase, mm	9.5a	11.6b	14.2c	13.5bc
Taper, mm/m	7.8a	9.7b	12.5c	11.7c
<i>Liquidambar styraciflua</i> —Saratoga				
Height increase, cm	113a	95b	81b	60c
Caliper increase, mm	8.5a	9.3ab	10.8c	9.9bc
Taper, mm/m	6.7a	8.0ab	9.5bc	11.2c
<i>Pistachia chinensis</i> —Saratoga				
Height increase, cm	101a	107a	69b	58b
Caliper increase, mm	4.5a	4.3a	6.4b	4.9ab
Taper, mm/m	4.4a	3.3a	7.1b	7.5b
<i>Quercus ilex</i> —Saratoga				
Height increase, cm	68a	88b	71a	63a
Caliper increase, mm	3.4a	4.4b	5.4b	6.4c
Taper, mm/m	7.3a	7.1a	8.4a	10.6b
<i>Schinus terebinthifolius</i> —ABC				
Height increase, cm	127a	119ab	109b	95c
Caliper increase, mm	13.6	14.4	13.6	11.6
Taper, mm/m	10.1	11.7	11.6	11.0

\* Treatments

STAKED—trunk tied to a 1 x 1 x 60" stake.

UNSTAKED—trunk not tied to a stake.

REMOVED—laterals on lower half of trunk removed during season.

HEADED—laterals on lower half of trunk headed during season.

UNPRUNED—laterals on trunk not pruned.

† Locations

ABC—ABC Nursery, Gardena, Los Angeles County.

Oki—Oki Nursery, Sacramento.

Saratoga—Saratoga Horticultural Foundation, Santa Clara County.

‡ Values on any line followed by different letters differ significantly at the 0.05 level or higher according to Duncan's Multiple Range Test.

branching habit and response to pruning. Because Shamel ash does not branch on current growth, there were no laterals to prune. Chinese pistache and holly oak had sparse and variable branching. The other species had abundant laterals.

### Root systems

Root systems of the staked trees were smaller in 6 of the 7 sets of trees measured when the lower laterals were completely removed, as compared with heading (significant differences only for the mulga ironbark grown at Oki Nursery, however).

Comparison of lightly pruned and unpruned treatments (unstaked) showed greater growth differences than the severely pruned and lightly pruned treatments (staked). Heading the laterals along the lower half of the trunk produced taller trees in all species except silkoak. The mean increase of 21% for all species was significant. The response in caliper growth was variable. Caliper was significantly reduced in mulga ironbark at both locations and in holly oak. Although caliper increase in Chinese pistache and Brazilian pepper was greater than 15%, it was not significant.

### Heading vs. no pruning

Heading, compared with no pruning, reduced taper 15% to 55% in six comparisons, and had little effect in the other four. The reduction of 16% for all species was significant. The effects of heading compared with no pruning on root weight also was pronounced. Of the seven sets of trees examined, six had larger roots in the unpruned treatment, two significantly so.

### Influence

Assuming no interaction between staking and pruning, the influence of removing laterals, compared with not pruning them, can be estimated by multiplying (from table 2) the percentage for the 'headed/unpruned' by that for the 'removed/headed' and dividing by 100. For mulga ironbark at ABC Nursery, for example, the total influence of lateral removal on height would be  $130 \times \frac{106}{100} = 138\%$  or, on caliper, would be  $80 \times \frac{89}{100} = 71\%$ .

The pruning treatments had a greater influence on root weight than did staking. Comparing all seven sets examined, removal of laterals compared with heading, and heading compared with no pruning, each increase in severity of pruning resulted in about 20% reduction in root weight.

Refinement of cultural practices to optimize height growth and trunk development should be undertaken. Some of the variability in response may have been due to the infrequent attention (3 to 4 weeks) given during this experiment and, therefore, the rather severe heading of laterals at each pruning. Severe pruning decreases lateral growth. More frequent but lighter pruning might be more effective and result in more consistent plant response.

Treatments might have been more effective if started when the plants were first moved to gallon cans. This is indicated by observations at Davis, where eucalyptus and other species have been grown successfully without stakes if given adequate space and not left too long in liner pots or gallon cans.

Even though differences between certain treatments were not always significant, the consistent trends in height reduction and increased caliper growth, taper, and in root weight (as the severity of pruning decreased and stakes were removed), give validity to the following generalization: rigid staking and severe pruning of lower laterals of young nursery trees produce plants with greater height at the expense of caliper, taper, and root development. Thus, to produce young trees that can stand in the landscape without staking, rigid staking should be avoided, and pruning should be moderate.

Although the unpruned, unstaked treatment resulted in trees with the largest caliper, taper, and root systems, this procedure may have limited nursery application because of reduction in height growth, additional growing space required, and difficulty of maintenance. These plants were grown on 24-inch spacings.

The laterals-headed, unstaked treatment produced trees judged to be an acceptable compromise between height growth, and trunk development. Trees produced by this treatment had satisfactory height growth for the species, a full crown (good apparent size), and trunks capable of standing erect without stakes (see photos).

Some species are more adapted than others to growing upright without support. Even within some species, upright growth may be quite variable, depending on seed source or variation within seed source. A tree's ability to stand alone usually can be determined by the end of the liner stage. Those that can stand alone should be separated from those that cannot. The first group can be grown

TABLE 2. RELATIVE INFLUENCE OF STAKING AND PRUNING TRUNK LATERALS FOR 5 MONTHS ON HEIGHT, CALIPER AND TAPER OF CONTAINER-GROWN TREES.†

Species, location‡	STAKED/UNSTAKED§			STAKED			UNSTAKED		
	Height %	Laterals Headed		Height %	Laterals Removed/Headed		Height %	Laterals Headed/Unpruned	
		Caliper %	Taper %		Caliper %	Taper %		Caliper %	Taper %
Betula verrucosa—Oki	122	90	85	97	88	95	150*	95	73**
Eucalyptus polyanthemos—SHF	138*	84*	63**	100	84	98	133	91	58**
E. sideroxylon—Oki	158**	73**	66*	94	94	81	110	77**	84
E. sideroxylon—ABC	108	92	81	106	89	84	130*	80*	56**
Fraxinus uhdei—ABC	113	89	66**	99	106	98	106	97	98
Grevillea robusta—ABC	110*	82**	78**	100	82*	80*	100	105	107
Liquidambar styraciflua—SHF	117	86*	84	119*	91	84	136*	109	85
Pistachia chinensis—SHF	154**	67*	46**	95	105	133	118	131	95
Quercus ilex—SHF	125*	81	85	76**	77*	103	113	84*	79*
Schinus terebinthifolius—ABC	109	106	101	107	94	86	115*	117	105
Mean	125**	85*	76**	99	91	94	121**	99	84*

† Treatments

STAKED—trunk tied to a 1 × 1 × 60" stake.

UNSTAKED—trunk not tied to a stake.

REMOVED—laterals on lower half of trunk removed during season.

HEADED—laterals on lower half of trunk headed during season.

UNPRUNED—laterals on trunk not pruned.

‡ Locations

ABC—ABC Nursery, Gardena, Los Angeles County.

Oki—Oki Nursery, Sacramento.

SHF—Saratoga Horticultural Foundation, Santa Clara County.

§ Comparisons are between treatments in CAPITALS in heading and are expressed as percentage that the first is of the second, e.g.: STAKED divided by UNSTAKED × 100.

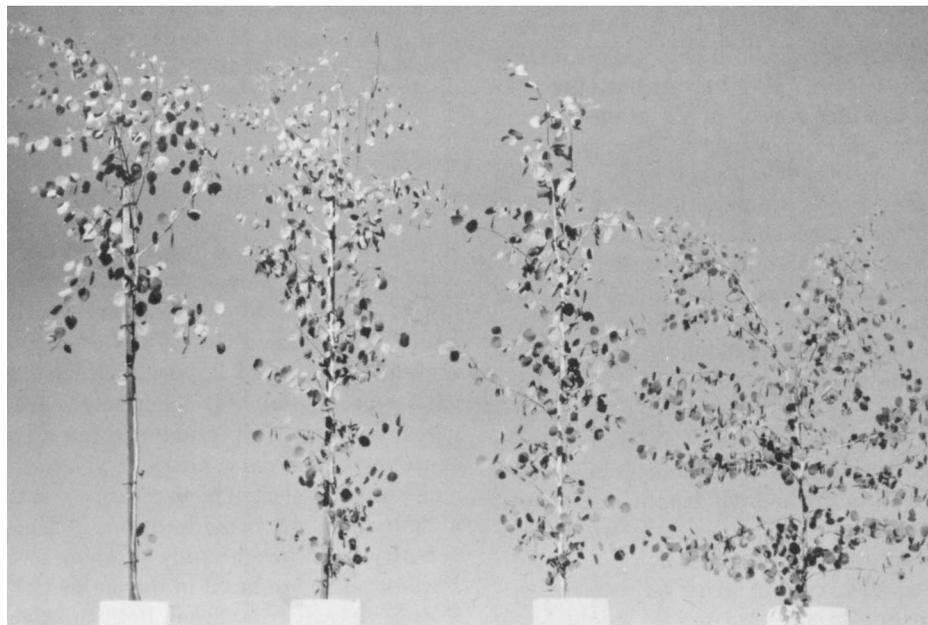
\* Treatments significantly different at the 0.05 level or higher.

\*\* Treatments significantly different at the 0.01 level or higher.

without support if given proper spacing. Depending on the number and their condition, the others can be grown with minimum staking or discarded. Modifications in nursery staking practice should start with those species that easily grow upright, and then be extended to other species as suitable cultural practices are developed.

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Round leaf eucalyptus 5 months after starting the staking and pruning treatments. Left to right: Staked—lower laterals removed; staked—lower laterals headed; unstaked—lower laterals headed; and unstaked—unpruned.