VEGETATIVE PROPAGATION OF MATURE SYCAMORE

Samuel B. Land, Jr, [1]

Abstract.--Techniques were tested for grafting, budding, and rooting cuttings from mature sycamore trees. Success was greater for winter and spring grafting (50-66%) and fall and winter budding (45-55%) than for rooting of hardwood cuttings (3%) or spring and summer budding (0-5%). Topophysis was present in grafts four years after grafting. Ortet ranks differed among propagation methods, and significant ortet variation for each method was not always associated with age. Waxed cleft grafts using scions from only the past year's growth increment are recommended for grafting sycamore, and fall T-budding can be used to extend the propagation period.

Additional keywords: Grafting, budding, rooting of cuttings, tree breeding, Platanus occidentalis.

Libby (1974) summarizes uses of vegetative propagation in tree breeding programs. The most common and probably most important present use is the movement of genotypes intact from scattered selected trees to a common site, usually called a clone bank or clonal seed orchard. Examination of vegetative propagation techniques for cloning selected trees in breeding programs of American sycamore (Platanus occidentalis L.) is the objective of the studies reported here. Ortet effects on success of various propagation methods are also evaluated.

Sycamore trees selected for a breeding program are usually physiologically mature. Little information is presently available on optimal grafting and budding techniques for such trees, and limb cuttings are hard to root. Kormanik and Brown (1974) and Hare (1976) have determined methods for increasing rooting success of cuttings from mature sycamore, but their methods have limited application for valuable, scattered trees in a breeding program. Foster's 2/ report is the first on ortet variation in rooting response for mature trees. Nothing has been reported on magnitudes of ortet variation and relative performances of ortets for other vegetative propagation techniques.

MATERIALS AND METHODS

In 1973, ten sycamore trees of ages 8, 11, 19, 21, 22, 22, 50, 55, 55, and 58 years at DBH from near Mississippi State University (33°14'N., 88°54'W.) were used as sources of vegetative propagules for four propagation studies. Treatments in the studies were selected based on results noted for other plants (Hartmann and Kester 1968).

Greenhouse Grafting Study

Side grafts were made on potted 1-0 rootstock brought into the greenhouse three weeks prior to grafting. All grafts were wrapped with a budding rubber and waxed with asphalt grafting compound. Treatments consisted of

[1] Associate Professor, Department of Forestry, Mississippi State University, Mississippi State, MS. Contribution No. 3609 of the Mississippi Agricultural and Forestry Experiment Station.

IBA powder followed by a dip in 5% captan powder, or (3) a dip in 5% captan powder only. At planting, the cuttings were stuck four inches deep in one-gallon pots containing either sand or a 1:1 peat:perlite mixture, which represented the second treatment factor. The pots were placed on a mist bench in a greenhouse, with one cutting per pot. Four collection-storage procedures for the cuttings, representing the third treatment factor were collection and planting without cold storage in (1) mid February (2) mid March, and (3) late September, and (4) collection in mid February with four-week cold storage before planting. A split-plot design with collection-storage procedures as whole units, four replications, and five cuttings per plot was used. Ortets were represented twice in each treatment combination. Survival was recorded in June and October for February and March plantings and in April, 1974, for the September planting. All cuttings were examined in April for presence of roots. Analyses of variance and Duncan's tests were used for the survival data and for percent of cuttings with root formation.

Comparison of Ortet Performance for Different Methods

Analyses of variance for randomized complete block designs with two replications were used to test significance of ortet variation for each method and trait. Ranked ortet means for age, percent success of each of the methods, and topophysis code were compared by Spearman's coefficient of rank correlation.

RESULTS AND DISCUSSION

Six months after grafting there was little difference between greenhouse and nursery grafting success (Table 1). Graft survival dropped from

Table 1.--Percent grafting and budding success of scions and buds collected from mature sycamore trees

Dates (Mo. & Day) in 1973		Location	Percent Success[a/]		
Scions or Buds Collected	Grafted or Budded	of Rootstock	June 1973	September 1973	April 1974
Grafting:					
Feb 9-12	Feb 13-14	Greenhouse	86	60 A	-
Feb 19-20	Mar 12-13	Greenhouse	75	50 A	-
Feb 19-20	Mar 19-22	Nursery	63	53	-
Budding:					
Feb 9-12	Feb 13-14	Greenhouse	-	55	-
Feb 19-20	Mar 28	Nursery	-	0	-
Jun 21	Jun 21	Nursery	-	5	-
Sep 26	Sep 27	Nursery	-	-	45

[a/] Means followed by the same letter are not significantly different at the 5% probability level.

June to September, indicating that grafting success should not be assessed before the end of the growing season following grafting. The mortality of apparently successful grafts may result from increased summer water stress in grafts with poor unions. Shock of moving the potted grafts 15 miles in an open truck from the greenhouse to a shadehouse in late June may also have affected ultimate success of the greenhouse grafts.

Neither date of collection-storage nor age of the "heel" of the scion had a significant effect on greenhouse grafting success (Tables 1 and 2).

Table 2.--Effects of location and treatment on grafting success and degree of topophysis of sycamore grafts from mature trees a/

Location and Treatment	Percent Success Six Months After Grafting	Degree of Topophysis in 4-Year-Old Grafts
Greenhouse:		
"Heel" wood age of scion:		
Previous Year's Growth (1972)	64 A	-
2-Year-Old (1971)	53 A	-
Nursery:		
"Heel" wood age of scion:		
Previous Year's Growth (1972)	61 B	2.2 G
2-Year-Old Growth (1971)	45 C	2.2 G
Type of graft:		
Side Graft	54 D	2.4 H
Cleft Graft	52 D	2.0 I
Protection from moisture loss:		
Not waxed, not covered	44 E	1.9 J
Not waxed, covered with bag	51 EF	2.3 K
Waxed, not covered	64 F	2.4 K

a/ Means for a particular treatment and trait, when followed by the same letter, are not significantly different at the 5% probability level.

However, success in the nursery was greatest if the scion consisted of the previous year's growth increment and the graft was waxed, but not covered (Table 2). Side and cleft grafts gave equal success. The discrepancy between the two locations of grafting for significance of "heel" wood age may reflect differences in moisture stress at time of graft union formation or differences in precision of the two experimental designs. It is recommended from these results that scions consisting of the previous year's growth be used in either greenhouse or nursery grafting of mature sycamore, and that the grafts be waxed, but not covered.

After four years, 85 percent of the surviving nursery grafts exhibited some degree of topophysis, where the graft was growing like a limb. Side grafts exhibited a significantly higher degree of this effect than cleft grafts (Table 2). Possibly, tardy removal of rootstock tops

above the side graft union (done one month after grafting) could influence this result, but the persistance of the effects over four years makes this unlikely. The fact that unwaxed, non-covered control grafts gave less topophysis effect than the waxed or covered grafts cannot be explained. The recommendation here is to use cleft grafts for sycamore, since cleft grafts give equally as good survival as side grafts, are easier to make, and result in less topophysis effect.

Budding

Winter budding in the greenhouse and fall budding in the nursery were equally as successful as spring grafting in the greenhouse or nursery, but spring and summer buddings were failures (Table 1). At no time did the bark "slip" easily on sycamore. This difficulty with bark slippage makes T-budding of sycamore as slow as cleft grafting and more tedious. However, fall budding can be used to extend the period during the year when select sycamore trees can be successfully propagated in clone banks or clonal orchards.

Rooting of Cuttings

Survival of cuttings after seven months in the greenhouse was only three percent, even though up to 25 percent of the cuttings had evidence of root formation (Table 3). Even more cuttings initially leafed out,

Table 3.--Root formation and survival of cuttings collected from mature sycamore trees and planted on a greenhouse mist bench

Dates (Mo. & Day) in 1973		Percent Survival			Cuttings
Cuttings Collected	Cuttings Planted	June 1973	October 1973	April 1973	Having Root Formation (%)[a/]
Feb 9-12	Feb 14	13	2.5	-	14 A
Feb 19-20	Mar 23	28	1.7	-	15 A
Mar 22-23	Mar 23	34	2.5	-	26 A
Sep 26-27	Sep 27	-	-	5.8	13 A
Overall mean		25	------ 3 -------		17

a/Means followed by the same letter are not significantly different at the 5% probability level.

probably from stored food reserves, but died. It appears that rooting success of sycamore cuttings should not be determined strictly by presence of roots or by early leafing out, but rather by survival at least six months after planting the cuttings.

Neither growth regulator nor soil medium affected the percent of cuttings with roots, and a significant effect of growth regulators on survival was not meaningful in actual amount (Table 4). More recent work with nine of these same ten ortets[3/], using a 0.5% IBA and 0.5% PPZ (1-phenyl-3-methyl-5-pyrazolone) in 50% ethanol plus 20% sucrose and 5%

3/A cooperative study between R. C. Hare of the U. S. Forest Service in Gulfport, Mississippi, and the author.

Table 4.--Effects of growth regulator and soil rooting medium on root formation and survival of sycamore cuttings collected from mature trees and planted on a greenhouse mist bench

Treatment	Percent Survival Seven Months After Planting	Cuttings Having Root Formation(%)
Growth Regulator:		
0.8% IBA Powder + Fungicide	5.0 A	23 D
Fungicide (control)	3.8 AB	15 D
0.5% IBA + 0.5% NAA + Fungicide	0.6 B	13 D
Soil Medium:		
Sand	2.9 C	16 E
Peat:perlite (1:1)	3.3 C	18 E

[a]/Means for a particular treatment and trait, when followed by the same letter, are not significantly different at the 5% probability level.

captan in talc, has given up to 57 percent of cuttings with root formation. It appears that hardwood limb cuttings detached from mature sycamore trees can be rooted, but that the treatments of the present study were not appropriate.

Ortet Effects

Variation among ortets was significant for percent of cuttings with root formation, fall budding success, grafting success, and degree of topophysis exhibited by four-year-old nursery grafts (Table 5). Crown

Table 5.--Effect of ortet on root formation of cuttings, fall budding success, greenhouse grafting success, nursery grafting success, and topophysis of nursery grafts from mature sycamore trees a/

Ortet No.	Age at D.B.H. (yrs.)	Cuttings with Root Formation	Fall Budding Success	Grafting Success Greenhouse (%)	Grafting Success Nursery (%)	Degree of Topophysis
07	58	.5 E	37 FG	63 HI	30 N	2.15 PQR
01	55	.9 DE	7 G	31 J	29 N	2.85 O
06	55	10 CDE	37 FG	69 HI	83 K	2.10 QR
05	50	12 CD	63 FG	69 HI	38 MN	1.90 R
03	22	11 CDE	50 FG	44 IJ	63 KLMN	2.50 OPQ
08	22	8 CDE	37 FG	63 HI	42 LMN	2.10 QR
09	21	37 A	85 F	56 HI	75 KLM	2.20 PQR
10	19	2 DE	50 FG	63 HI	25 N	1.15 S
04	11	15 BC	63 FG	75 H	71 KLM	1.75 R
02	8	34 AB	16 G	50 HIJ	80 KL	2.65 OP

a/Ortet means for the same trait, when followed by the same letter, are not significantly different at the 5% probability level. Tests and means were obtained from % data transformed to arcsin $\sqrt{\%}$ for root formation and budding success, but were derived from non-transformed data for the other three traits. Maximum and minimum ortet means are underlined.

position effect should not be a contributing factor, since the means are based on many propagules taken from throughout the crown, (48 cuttings, eight fall buddings, 16 greenhouse grafts, and 24 nursery grafts per ortet). Age of ortet was not always important, since only one significant correlation between ortet ranking for age and for other traits was obtained: a negative correlation ($r = -0.66$) between age and percent of cuttings with root formation. It therefore appears that other factors, such as tree vigor and genotype, are primary influences on the ortet variation noted.

Ortets differed in relative rank from one method of vegetative propagation to another (Table 5). The only significant rank correlation was a positive one ($r = 0.71$) between percent of cuttings with root formation and percent grafting success in the nursery. Apparently, different physiological and (or) anatomical factors influence success of the different propagation methods. Genetic and environmental control of each factor may be independent of such control for other factors, so that an ortet would not react relatively the same as another ortet to different methods. Therefore, for establishment of clone banks or clonal orchards the inability to vegetatively propagate a selected tree by one method does not exclude the possibility of propagation by another method. For example, ortet 02 buds poorly, but roots and grafts well, while ortet 10 buds well and does poorly in rooting or nursery grafting. On the other hand, ortet 09 does well for all methods, and ortet 01 does poorly in all methods.

SUMMARY AND CONCLUSIONS

Under the conditions of these studies propagation success with physiologically mature sycamore propagules was better for winter and spring grafting (50-66%) and fall and winter budding (45-55%) than for rooting cuttings on a greenhouse mist bench (3%) or spring and summer budding (0-51). Nursery grafts were more successful when the scion was taken from the previous year's growth increment than when it had a "heel" of two-year-old wood (61% vs. 45%). Waxed nursery grafts exhibited higher success (64%) than unwaxed grafts covered with polyethylene and kraft bags (51%) or unwaxed and uncovered grafts (44%). Side grafts and cleft grafts were equally successful in the nursery. Topophysis, where the graft was growing like a limb, was apparent in four-year-old nursery grafts and was significantly greater for side grafts than for cleft grafts. In greenhouse rooting of cuttings, neither date of collection and storage, growth regulator treatment, or soil medium had any meaningful effect on rooting success. Ortet variation was significant for percent of cuttings with root formation, fall budding success, greenhouse grafting success, nursery grafting success, and degree of topophysis on nursery grafts. Only ortet ranking for percent of cuttings with roots was significantly correlated with age of ortet ($r = -0.66$). Ortet ranks were usually not correlated for different propagation methods.

Based on these results, recommendations for vegetative propagation of mature sycamore trees in establishment of clone banks or clonal orchards are as follows:

(1) Until suitable methods are developed for rooting hardwood limb cuttings, grafting and budding should be used.
(2) For winter and spring grafting in the greenhouse or nursery use waxed cleft grafts and scions taken from the previous year's growth increment.

(3) Use T-budding in the fall to extend the period during the year when successful vegetative propagation can be accomplished.
(4) If difficulties are experienced in one method of propagating a select tree, try alternative methods (such as greenhouse vs. nursery grafting or spring grafting vs. fall budding).

LITERATURE CITED

Hare, R. C. 1976. Girdling and applying chemicals promote rapid rooting of sycamore cuttings. U.S.D.A. , Forest Service, So. For. Exp. Sta. Res. Note S0-202, 3 pp.

Hartmann, H. T. and D. E. Kester. 1968. Plant propagation principles and practices (2nd ed.). Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 702 pp.

Kormanik, P. P., and C. L. Brown. 1974. Vegetative propagation of some selected hardwood forest species in the southeastern United States. New Zealand J. For. Sci. 4(2): 228-234.

Libby, W. J. 1974. The use of vegetative propagules in forest genetics and tree improvement. New Zealand J. For. Sci. 4(2): 440-447.