PROVENANCE AND GROWTH STUDIES OF BASSWOOD

William C. Ashby and David T. Funk 1/

Abstract.--Site quality influenced height growth of 15-year-old basswood plantations much more than did geographic origin of the seed. In plantations under forest overstory the greatest average height for an accession was 5 feet. On a clearcut site it was 35 feet with DBH 2.9 inches.

Additional keywords: Planting survival, height growth, site classification, Tilia americana.

Basswood (Tilia americana L.) ranges from 35° to 50° north latitude, east of the 100° meridian. We compared the 15-year growth performance of accessions from several parts of this range on a series of planting sites in Illinois and adjacent Indiana. Growth performance was primarily reported as height, and additional growth features were noted. These studies furnish information on site requirements for basswood, and on possible racial diversity.

METHODS AND RESULTS

April plantings of seedlings lined out for 1 or 2 years were made on varied sites using a planting bar. The accessions and major planting sites are identified in Table 1. Three plantings under mixed-oak forest cover received no subsequent cultural treatment. Plantings in open areas were weeded or released on various occasions. Five plantings were in Latin squares, and two were non-randomized row plantings.

Survival

Survival of the basswood accessions was strongly related to site (Table 1). Most seedlings that died did so in the first few years. Greatest survival was found under the mixed-oak forest overstory, and in southern Illinois substantially exceeded that in northern Indiana (97 and 98% versus 62%). Survival was somewhat less (88%) in southern Illinois on a clearcut site (trees cut and not removed) and was still less (34%) on an eroded old-field site with a thin annual-lespedeza cover at planting.

1/ Professor, Botany Department, Southern Illinois University, and Principal Plant Geneticist, North Central Forest Experiment Station, USDA Forest Service, Carbondale, Illinois 62901. We wish to thank Dr. Stephen G. Boyce, and supporting personnel of the Carbondale Forest Research Center, for substantial cooperation in the setting up of the studies at the Kaskaskia Experimental Forest. This investigation was aided by grants from the National Science Foundation and from the Dr. Wallace C. and Clara A. Abbott Memorial Fund of the University of Chicago.

Plantings of a diversity of accessions were made on a rototilled and fertilized old field in DuPage Co., northern Illinois. Circumstances such as the mowing of part of the plot area and a later change of ownership led to incomplete results from this study. Two-year seedlings had higher survival than first-year stock. Small seedlings experienced winter animal damage. After 13 years 30% of 152 seedlings survived, with the Marathon Co., Wisconsin accession 78% and Lake Geneva 39% survival. Several accessions including Ohio had complete mortality.

Table 1.--Percent survival of basswood accessions on slope plantings in varied locations at plantation age 15 years

Accession[2/]	Porter Co. NW Indiana Forest[b/]	Hardin Co., Southeastern Illinois Forest[b/]	Field[b/]	Forest[c/]	Clear-cut[c/]
	Percent				
Cook Co., IL 1-yr.	69	100	31	-	-
Porter Co., IN 1-yr.	62	100	38	-	-
Athens, OH 1-yr.	44	94	12	-	-
Marathon Co., WI 2-yr.	75	94	56	95	95
Lake Geneva, WI 2-yr.	-	-	-	100	95
Heuvelton, NY 2-yr.	-	-	-	100	-
Potter, NY 2-yr.	-	-	-	95	60
Williamstown, MA 2-yr.	-	-	-	-	100
Plot Mean	62	97	34	98	88

a/ All accessions were single-tree seed collections except Cook Co., Ill. and Marathon Co., Wisc.
b/ 4x4 Latin Square, 4 trees per plot, 4-foot spacing, 1959 to 1973.
c/ 5x5 Latin Square, 4 trees per plot, 6-foot spacing, 1961 to 1974.

A summer planting of first-year stock in the northern Illinois old field had only 4% survival. Spring, and summer, plantings on garden areas in Chicago and in southern Illinois had essentially 100% survival.

Growth

After 14 or 15 years height growth of basswood planted under forest cover ranged from 2 to 5 feet, with no statistically significant growth differences at the 5% level (Table 2).

Table 2.--Average height growth of basswood accessions on slope plantings in varied locations at plantation age 15 years based on two tallest trees

Accession	Porter Co., NW Indiana: Forest	Hardin Co., Southeastern Illinois: Forest	Hardin Co., Southeastern Illinois: Field[a/]	Hardin Co., Southeastern Illinois: Forest[b/]	Hardin Co., Southeastern Illinois: Clearcut[b/]
	Feet				
Cook Co., IL	3.7	3.3	2.3	-	-
Porter Co., IN	2.1	4.4	3.9	-	-
Athens, OH	5.1	4.7	1.6	-	-
Marathon Co., WI	5.2	5.3	3.0	2.8	28.5
Lake Geneva, WI	-	-	-	3.8	31.3
Heuvelton, NY	-	-	-	3.1	-
Potter, NY	-	-	-	2.6	31.5
Williamstown, MA	-	-	-	-	35.6

a/ Growth of all surviving trees. Because of the large number of missing plots, these data were not included in the statistical analyses.
b/ Fourteen-year height results were adjusted to a 15-year basis. For the clearcut plot the DBH were 2.0, 2.2, 2.4, and 2.9 inches using the 14-year measurements.

Many plants died back and sprouted repeatedly to achieve the reported heights. Falling limbs damaged many seedlings. Very little rabbit or other damage was noted.

Growth in the clearcut area seemed excellent, averaging about 2 feet a year throughout the 14-year period, with no statistical significance in growth among accessions. Tree form was generally good. This may have been related to shade cast by vigorous growth of competing vegetation, primarily yellow-poplar (Liriodendron tulipifera L.). Basswood foliage showed extensive leaf spots, likely linden anthracnose, and many leaves had been shed in August 1974 when competing species showed little leaf spot or dropping. The competing vegetation was cut back on several occasions after individual trees equaled or overtopped the basswood.

Comparison with 5-year height growth on a garden area in Jackson Co. suggests that growth of basswood even in the clearcut plot was less then optimum (Table 3). Under garden conditions with weeding, some fertilizing, and first-year watering but with a 2- by 4-foot spacing compared to a 6- by 6-foot spacing, the trees made about twice as much height growth as in the field planting. The garden trees were not planted in an experimental design, and statistical analyses were not carried out.

Table 3.--Average height growth of all trees on two planting sites in southern Illinois

Accession	Jackson Co. Garden		Hardin Co. Clearcut		
	5-year	# trees	5-year	10-year	# trees
	Feet				
Marathon Co., WI	18.3	18	8.7	17.6	20
Lake Geneva, WI	19.0	27	8.7	18.2	20
Potter, NY	14.1	14	9.0	18.1	15
Williamstown, MA	19.4	8	10.2	22.1	20
Plot Mean	17.7		9.2	19.0	

Southern Illinois Old Field

The soil of the old field in Hardin Co. was strongly acid with a high clay content. Site quality was probably worse than most old-field areas in southern Illinois judging from the naturally invading species, chiefly a low cover of three-awn grass (Aristida spp.). The accessions on that site grew less well than on most of the other planting sites (Table 2). The Wisconsin seedlings which had greater size at planting seemed to be benefited more in survival than in growth.

Trees on the old field had light green or yellow foliage, red petioles by mid summer, and early leaf fall. Dying back and sprouting was a common occurrence. The larger trees were all at the bottom of the slope (plot). A hazard these trees alone experienced was extensive damage and breakage from egg-laying slits on all larger twigs and stems in the 1972 growing season made by periodic cicadas (13-year locust). These old-field trees also experienced damage from a twig-cutting insect.

Other Topics

The incomplete data from the northern Illinois old field are not presented in the tables. Growth of those accessions with 9 to 19 surviving trees averaged less than one foot per year the first 9 years, and over 2 feet per year to age 13. Invading species such as hawthorn (Crataegus spp.) and silver maple (Acer saccharinum L.) emerged from the waist-high herbaceous layer about the same time as the basswood, and individuals have grown faster than the basswood. Clearing of the weeds from one plot increased basswood mortality. As in two other plot comparisons, the Lake Geneva accession had better growth than the Marathon Co., Wisconsin trees.

Three plantings had additions of fertilizer and lime at or prior to planting. Fertilizing the northern Illinois old-field plots stimulated rank herbaceous growth and did not improve establishment of basswood.

Fertilizer was added in supplementary planting-bar slits on one forest site in southern Illinois at the time of planting the basswood. The only response noted was a darker green color on the poison ivy (Rhus radicans L.). On the adjacent similarly fertilized old-field plots a mound of crabgrass (Digitaria spp.) initially covered the basswood seedlings. The basswood didn't grow well, and have had yellowed foliage in subsequent years.

One type of geographic variation of basswood noted in the original stages of this study was differences in seed quality. Fruit collections obtained from several areas other than those reported were virtually all empty. Fruit from still other years yielded an inadequate number of good seedlings for experimental work. The quality of fruit for seed yield also varied with year of collection (Ashby 1962).

A possible genetic segregation for red or yellow winter-bud color was noted in the southern Illinois garden. Seedlings in two Wisconsin populations were scored 24 red to 0 yellow, and 31 red to 5 yellow. In three New York populations from single-tree collections the ratios were 16 to 2, 9 to 9, and 2 to 14 respectively.

Two southern Illinois basswood plantings included seedlings of northern red oak (Quercus rubra L.) from the Chicago area. The oaks grew very poorly and died back repeatedly with none left after 14 years under either forest or clearcut conditions.

DISCUSSION AND CONCLUSIONS

Basswood was highly sensitive to site conditions and showed no evident geographic racial (ecotypic) variations in growth relative to a high amount of variability within and between populations from one state. The test of two accessions each from Wisconsin and from New York showed greater variability in height within each state than between the averages of the two states.

The good growth on the clearcut site probably was due to favorable soil conditions. The limited growth under forest cover likely resulted from shading coupled with competition for water and nutrients. Poor survival and limited growth on the eroded old-field site, with little herbaceous growth except for the initial crabgrass, may have been caused by persistent nutrient limitation, most evidently nitrogen to which basswood is sensitive (Ashby 1959).

Basswood is found only in limited, localized habitats in southern Illinois, and none was growing in the locality of any plot. Natural basswood seedlings were present in the vicinity of the northern Indiana plots where growth under forest conditions was similar to that in southern Illinois, and survival was less.

Although geographic seed source seems to be of little importance, basswood plantations cannot be expected to have good survival and grow vigorously unless several conditions are met:

1. Selection of seed which gives a high percentage of vigorous seedlings.
2. Use of large 1-year, or of 2-year planting stock.
3. Continuing control of competing vegetation.
4. Removal of a forest overstory.
5. Planting on a forest soil, or on a productive field soil.

These recommendations are in substantial agreement with findings of Stroempl (1971) on hardwood sites in southern Ontario.

LITERATURE CITED

Ashby, W. C. 1959. Limitation to growth of basswood from mineral nutrient deficiencies. Bot. Gaz. 121:22-28.

Ashby, W. C. 1962. Germination capacity in American basswood. Trans. Ill. State Acad. Sci. 55:120-123.

Stroempl, G. 1971. Planting of basswood is successful in hardwood cut-overs. Tree Planters' Notes 22:26-29.