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THIRTEEN-YEAR GROWTH OF SOME GREEN ASH PROVENANCES IN THE NORTHEAST

Green ash (*Fraxinus pennsylvanica* Marsh.) is one of the few native hardwood species that has been planted for afforestation in appreciable numbers in this country. In the Central States this species has been grown mainly on submarginal farmland and on strip-mine spoil banks, while in the Great Plains it has been planted for shelterbelts. In the Northeast, only limited experimental plantings have been attempted.

Ecotypic variation in the Great Plains population was reported by Meuli and Shirley (1937); they recognized three ecotypes based on resistance to artificially induced drought. Wright (1944) also distinguished three ecotypes among collections from the eastern United States and Canada: he found differences in seedling growth rate, petiole color, winter hardiness, time of height-growth cessation, and susceptibility to early frost damage.

This is a report on the growth performance of green ash from several provenances growing in three plantations established in 1951 and 1952 by Dr. Jonathan W. Wright while he was with the Northeastern Forest Experiment Station.

Materials and Methods

Seed was supplied by various cooperators throughout the species' range. Each seedlot was collected from a single mother tree. All but two of the seedlots were labeled by the collectors as *F. pennsylvanica* var. *lanceolata.* However, since Little (1935) does not recognize varieties of *F. pennsylvanica,* we followed his concepts and disregarded the varietal designations.

As received, the seed was stored dry in sealed containers in a refrigerator; later it was moist-stratified for several weeks in the refrigerator before sowing in the spring. The seedlings were grown in the nursery of the Morris Arboretum at Philadelphia, Pa. They were transplanted once and were outplanted as 1-1 stock. Each seedlot in a plantation was represented by 10 seedlings, except for a few lots for which only 8 or 9 seedlings were available. All seedlings in a plantation were completely randomized as single-tree plots.

The first plantation, designated GP-13-51, was installed in 1951 at the Hopkins Experimental Forest at Williamstown, Mass., on a well-drained upland site of Stockbridge loam. The area had been used for agriculture many years before but had reverted to a brush cover with hardhack (*Spirea latifolia* and *S. tomentosa*) predominating. The trees were planted at 8 x 8-foot spacing in plowed strips and were cultivated the first year.

Plantation GP-14-52, established in 1952, was also at the Hopkins Experimental Forest. The soil type here was Amenia loam. This area had been used as hay land for many years and had a heavy grass cover when the plantation was established. Planting was done in rototilled strips at an 8 x 8-foot spacing. The trees were not cultivated or mulched.

The third plantation, GP-1-52, was established in 1952 at the Beltsville Experimental Forest at Laurel, Md. The stock was the same as in GP-14-52 except that one additional Pennsylvania seedlot was included. The soil type was an imperfectly drained Beltsville loam. The area had been under intermittent cultivation for some 300 years and was in a condition of low fertility. The soil had been further depleted by the recent growth and removal of two crops of sod for landscaping purposes. As a result, the soil-type designation may not have been truly indicative of the quality of the site. For the test, the sparse ground cover—mostly seedling Virginia pine—was cleared off and the ash seedlings were planted in plowed furrows at an 8 x 8-feet spacing. All trees were heavily mulched with wood chips.

All plantings were measured in the fall of 1962, when the trees were 13 or 14 years old from seed. Height and diameter measurements were made only on trees that had not died back and resprouted during the last 5 years. Sprouted trees also were excluded from the survival figures; therefore actual survival was somewhat higher than reported here. Height and survival data were subjected to analysis of variance to ascertain both inter- and intra-provenance differences. In these comparisons, all collections from a given state were considered as a

single provenance because, despite some significant variation among seedlots within states, no significant variation among collection localities within states was evident. The range test of Tukey (Snedecor 1956) was used to compare provenance means from different points in the array.

Results and Discussion

The growth of green ash is considered to be highly sensitive to site differences (Hansen and McComb 1958). We took no data on site characteristics other than the general history and condition of each planting area. However, tree growth was markedly better in plantation GP-13-51, which was on a brushy site and was cultivated the first year, than in the other two plantings, which were on grassy or open land and not cultivated (table 1). This superior performance in GP-13-51 is in accord with much other published and general experience, indicating (1) that planted hardwoods usually grow better on land that has been under tree or shrub cover, and (2) that they grow better when cultivated at least through the first year.

Differences in survival among provenances were highly significant in plantation GP-14-52, but not in the other plantations. The inhibiting effect of grass possibly influenced survival in this plantation to some extent, since the trees were neither cultivated nor mulched. The southern progenies had the highest dieback and mortality, perhaps caused by failure to harden off before fall frosts. For the three plantations collectively, 7 percent of the trees had died back during the last 5 years and resprouted: average survival with these trees included was 89 percent; when they were excluded, as was done in preparing table 1, average survival was 82 percent.

The main purpose of this study was to compare the growth of plants from various sources. Some of the differences in height among provenances in both Massachusetts plantings were highly significant. However, no significant differences developed in the Maryland planting. But how meaningful are the observed differences?

These tests suffer from a fault common to many so-called "provenance" tests in that they contain, for some localities, only a single seedlot from a single mother-tree. Other localities are represented by as many as 12 single-tree progenies. Thus these plantations are more like one-parent progeny tests of trees for which origin was the only basis of selection. The difficulties inherent in the establishment of a true provenance test are not unique to green ash, but are encountered

with any species that is characterized by sporadic distribution, infrequent seed years, and seed-storage problems. Obviously comparison of provenance samples of such varied composition as those in this study cannot be expected to yield much data of value. Perhaps the only valid conclusion that can be drawn with regard to provenance is that green ash from southern sources is not well adapted to western Massachusetts.

Of greater biological interest, then, is the variation among progenies within localities. The differences in height within provenances (all

Table 1. — *Growth and survival of green ash provenances in three plantations*

State	Seedlots	Survival	Average height [1]	Range in seedlot height averages	Intra-state seedlot differences in height [2]
	Number	*Percent*	*Feet*	*Feet*	
			GP-13-51		
Minn.	1	100	16.6	—	—
Iowa	6	98	15.2	13.1-19.3	*
Mont.	1	100	15.1	—	—
S. D.	3	100	14.3	13.8-15.5	n.s.
Maine	5	93	14.2	12.7-15.1	n.s.
Mich.	1	100	13.7	—	—
Neb.	5	93	13.4	10.5-17.8	**
Ind.	1	78	13.3	—	—
Md.	1	80	11.6	—	—
Ky.	1	60	8.8	—	—
			GP-1-52		
Minn.	3	85	6.5	5.1-7.2	n.s.
Neb.	3	87	5.9	5.2-6.8	n.s.
S. C.	1	100	5.5	—	—
Ind.	12	78	5.4	3.6-6.8	n.s.
Pa.	6	85	5.4	3.4-6.8	n.s.
Tenn.	1	88	4.6	—	—
S. D.	5	91	4.5	3.6-5.0	n.s.
			GP-14-52		
Neb.	3	83	10.2	9.9-10.5	n.s.
Minn.	3	100	9.8	8.2-13.7	**
S. D.	5	89	9.3	7.8-10.9	n.s.
Ind.	12	76	7.0	4.3-11.2	**
Pa.	5	61	6.5	5.4-7.2	n.s.
S. C.	1	44	4.9	—	—
Tenn.	1	12	4.0	—	—

[1] Brackets enclose means that do not differ significantly at the 5-percent level.

[2] n.s. = not significant; * and ** indicate significance at the 5-percent and 1-percent levels, respectively.

sources within a given state) were significant or highly significant in 4 of the 9 cases in the Massachusetts plantings where the provenance was represented by 3 or more seedlots (table 1). In some instances, the range in height within a provenance was nearly as wide as the total range of provenance heights within a plantation.

With respect to early growth in western Massachusetts of the green ash provenances that were sampled, it may be concluded that individual tree variation is at least as important, and perhaps more important, than variation among provenances. This aspect of individual variation in hardwoods has been neglected primarily because of the general lack of interest in hardwood planting. Both the infrequency of good seed years, and the customary practices in seed collection, nursery culture, and plantation establishment, have tended to encourage the use of single-tree test progenies. Such tests have erroneously been used to justify conclusions as to provenance, variety, or even species performance.

A provenance test is essentially a population study. But it is the individual tree, not the population, that must be selected as parent material for genetic improvement. As long as hardwood improvement research is continued on a relatively small scale, the use and maintenance of single-tree progenies in the testing programs is recommended as the most direct method for improvement. In such single-tree progeny testing, the relation between individual-tree variation and geographic variation obviously must be kept in proper perspective. The test results, at best, can only be suggestive of possible provenance differences.

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