Research Note

Fiber Lengths in Stems and Branches of Small Hardwoods on Southern Pine Sites

Floyd G. Manwiller

ABSTRACT. The 22 species selected for analysis comprise over 95 percent of the hardwood volume occurring on pine sites. Ten trees 6 inches in diameter at breast height (DBH) of each species were taken from throughout that portion of the species' range occurring in the South. Pie-shaped wedges, removed at 48-inch intervals along the stem and each branch, were combined within each of the two wood categories for weighted samples. Stem fiber lengths varied from 0.83 mm in red maple to 1.76 mm in black tupelo; branch fiber lengths were significantly shorter, varying from 0.66 mm in red maple to 1.40 mm in black tupelo.

THE SOUTH CONTAINS much forest land that is primarily suited to growing pine but is encumbered with hardwoods. Since hardwoods grow slowly on pine sites, annual productivity per acre is low. At present, the trees are being destroyed at great expense during conversion of the sites to pine. As demands for wood fiber increase, however, and processing technology develops, these small-diameter trees will probably be harvested. In some cases the entire tree will be chipped at the logging site.

To provide information on properties important to the reconstituted wood products industry, a program of research has been undertaken by the Southern Forest Experiment Station's Wood Utilization Laboratory at Pineville, Louisiana. Morphological characteristics, chemical constituents, and a limited number of physical properties will be evaluated for 22 hardwood species that comprise in excess of 95 percent of the hardwood volume occurring on southern pine sites (unpublished data from Forest Resources Research Work Unit, Southern Forest Experiment Station).

This paper reports measurements of fiber lengths.

Procedure

To provide data for this as well as subsequent reports, 10 trees of each species were cut – a total of 220 trees. The true hickories were considered as a group, because volumes are not available for individual species. The sample was restricted to trees 6 inches in DBH (5.5 up to 6.5 inches) outside bark, since large volumes occur in small-diameter classes. Sampling locations were broadly distributed throughout that portion of each species' range occurring in the 11-state area extending from Virginia to northern Florida and west to Arkansas and eastern Texas. Only one tree of a particular species was cut at a location. Pine sites were considered to be those presently supporting pine or known to have had pine stands.

Two-inch disks were removed at 48-inch intervals along the stem, with the lowest taken 24 inches above ground. The stem was considered to end at a point of branching above which it could no longer be distinguished. In some trees it extended to the minimum sampling diameter of 0.5 inch outside bark. In others, stem identity was lost at much larger diameters.

Each branch in the top was sampled. Disks were removed from branches at 48-inch intervals down to a diameter of 0.5 inch outside bark; the first disk of each branch was taken 24 inches from the stem. The procedure

The author is Principal Wood Scientist, Southern Forest Expt. Sta., USDA Forest Service, Pineville, La. This paper was received for publication in January 1974.

was repeated at each point of branching within the top.

Since the entire stem and branches will often be flaked or chipped, it should be of value to industry to know mean fiber lengths and their variability for these wood categories. Therefore, stem wood was sampled in proportion to its occurrence by volume by removing a 15-degree, pie-shaped wedge (measuring 3/4 inch along the grain) from each disk. The wedges were chopped into thin wafers, which were combined and then macerated with equal proportions of 6 percent hydrogen peroxide and glacial acetic acid. One hundred fibers (fiber tracheids and libriform fibers), selected 10 at a time, were measured with an ampliscope to obtain a mean length for each stem. The same procedure was followed to obtain mean fiber length for branch wood.

Results

The species are arranged in Table 1 by increasing length of fibers in stem wood. Differences of 0.1 mm or more are significant (at the 0.05 level) in stem wood, while in branch wood, differences of 0.09 mm or more are significant. Red maple has conspicuously shorter fibers (0.83 mm in stem wood and 0.66 mm in branch wood) than the other species. The longest fibers are in sweetgum (1.54 mm and 1.20 mm) and black tupelo (1.76 mm and 1.40 mm).

For each species investigated, fiber length averaged significantly shorter in branches than in stems. For all species combined

TABLE 1 *Stem and branch wood fiber lengths in 6-inch-diameter hardwoods growing on southern pine sites*[1].

Species	Tree mean age	Stem wood: Mean fiber length	Stem wood:	Stem wood: Among trees standard deviation	Branch wood: Mean fiber length	Branch wood:	Branch wood: Among trees standard deviation
	Years				mm		
Red maple (*Acer rubrum* L.)	40	0.83	0.143	0.047	0.66	0.121	0.058
Hackberry (*Celtis occidentalis* L.)	28	1.12	.201	.065	.86	.189	.066
Blackjack oak (*Quercus marilandica* Muenchh.)	39	1.14	.223	.105	.88	.175	.065
Green ash (*Fraxinus pennsylvanica* Marsh.)	37	1.16	.257	.087	.84	.181	.064
Post oak (*Q. stellata* Wangenh.)	51	1.18	.233	.052	.93	.184	.072
White oak (*Q. alba* L.)	41	1.22	.216	.058	.88	.186	.046
White ash (*F. americana* L.)	40	1.22	.258	.099	.87	.192	.064
Sweetbay (*Magnolia virginiana* L.)	39	1.24	.254	.062	.97	.210	.099
Winged elm (*Ulmus alata* Michx.)	47	1.25	.196	.068	.93	.193	.077
Northern red oak (*Q. rubra* L.)	40	1.27	.242	.092	.90	.191	.067
Water oak (*Q. nigra* L.)	39	1.27	.261	.102	.98	.211	.089
Hickory, true (*Carya* spp.)	54	1.29	.249	.116	.98	.220	.095
Southern red oak (*Q. falcata* Michx.)	35	1.29	.258	.083	.96	.217	.067
Black oak (*Q. velutina* Lam.)	39	1.30	.260	.067	.98	.203	.068
Cherrybark oak (*Q. falcata* var. *pagodaefolia* Ell.)	32	1.30	.273	.102	.94	.232	.075
American elm (*U. americana* L.)	40	1.30	.241	.115	.99	.237	.112
Scarlet oak (*Q. coccinea* Muenchh.)	33	1.30	.248	.068	.98	.204	.079
Shumard oak (*Q. shumardii* Buckl.)	34	1.31	.264	.113	.99	.216	.061
Laurel oak (*Q. laurifolia* Michx.)	33	1.34	.254	.086	1.01	.223	.063
Yellow-poplar (*Liriodendron tulipifera* L.)	27	1.39	.296	.092	.97	.193	.105
Sweetgum (*Liquidambar styraciflua* L.)	29	1.54	.302	.123	1.20	.240	.069
Black tupelo (*Nyssa sylvatica* Marsh.)	59	1.76	.324	.140	1.40	.268	.134

[1]Data are based on a 10-tree sample of each species.

branch mean fiber length was 24.4 percent shorter than that of the stem. Branch means ranged from 20.5 percent shorter in red maple and black tupelo to 30.2 percent shorter in yellow-poplar.

The tree selection procedure insured the sampling of the wide range of growing conditions and tree ages for 6-inch trees on pine sites. Tree age varied from a mean of 27 years in yellow-poplar to 59 years in black tupelo; the average age for all species was 39 years. Therefore, the "among-tree" standard deviations listed in Table 1 probably are close to the maximums for weighted stem averages to be found among trees on pine sites. For both stem wood and branch wood, variability within the tree averaged 2.7 times greater than that among trees within a species. Standard deviation within trees averaged 0.248 mm in stem wood, while among trees within a species it averaged 0.089; for branch wood the corresponding values were 0.204 and 0.079.

Fiber lengths for 14 of the species are given in Table 5-5 of Panshin and de Zeeuw's text[1], and Bergman[2] has reported values for 12 of the same species; but differences in stem sampling methods probably render comparisons invalid.

By definitions applied to dicotyledonous woods[3], red maple stem fibers are "moderately short," those of black tupelo are "moderately long," and those of the other 20 species are "medium-size." For branch wood, fiber lengths are classified as "very short" in red maple, while the remaining species are classified as "moderately short" (0.7 to 0.9 mm) to "medium-size" (0.9 to 1.6 mm).

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[1]Panshin, A. J., and de Zeeuw, C. 1970. Textbook of Wood Technology. 3d ed., Vol. 1. McGraw-Hill, New York, N.Y.

[2]Bergman, S. I. 1949. Lengths of hardwood fibers and vessel segments. A statistical analysis of forty nine hardwoods indigenous to the United States Tappi 32:494-496.

[3]Standard terms of length of vessel members and wood fibers. 1937. Tropical Woods No. 51. p. 21.