Wood and Bark Moisture Contents of Small-Diameter Hardwoods Growing on Southern Pine Sites

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ABSTRACT. Ten 6-inch trees from throughout the South were sampled from each of 22 species, of which 11 were oaks. Ranking of species remained constant regardless of whether moisture contents were determined for the entire tree, the stem with bark, branches with bark, or stem- and branchwood without bark. For ashes and hickory, the range among these various components was 46 to 57 percent; for oaks, red maple, hackberry, and elms 55 to 78 percent; for black tupelo 85 to 90 percent; for sweetbay all moisture contents were close to 101 percent; and in yellow-poplar and sweetgum the range was 105 to 120 percent. Stem bark and branch bark moisture contents ranged from 44 percent and 56 percent, respectively, in blackjack oak, to 126 and 134 percent in yellow-poplar. Stemwood moisture content was higher than that of branchwood in 15 species; moisture content of stem bark was lower than that of branch bark in 19 species. In the stem, bark moisture content was higher than that of wood in 6 species and lower in 14 species. In the top, moisture content of bark was greater than that of wood in 16 species; the other 6 species had no significant difference.

IN CONTINUATION OF RESEARCH (Manwiller 1974; Choong, Tesoro, and Manwiller 1975) to determine important wood properties of hardwoods growing on southern pine sites, this paper reports data on moisture contents (MCs) of wood and bark from both stems and tops. The species sampled comprised about 95 percent of the volume of hardwoods on such sites. The bulk of the wood is in small, hard-to-utilize trees; the 6-inch-diameter class was sampled since in volume it is probably the largest single class.

Procedure

In total, 220 trees were cut – 10 of each species. The true hickories were sampled as a group because pine-site volume data were not available for individual species.

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. Trees were collected from July 28 to December 19, 1972. All were between 5.5- and 6.5-inches diameter breast height (DBH).

MCs of stemwood and bark were determined from four cross-sectional disks taken from the bole: at 2 feet above ground, at the top, and at one-third and two-thirds of the distance to the top. The bole was considered to end at the point where a central axial ster could no longer be distinguished. In additior 10 disks were randomly selected fror throughout the top.

All disks were 2 inches thick. Each wa immediately sealed in plastic, placed in polyethylene bag, and taken to the laborator where wood and bark were separated an ovendried. On the average, 6-1/2 days elapse from the time the sample was cut until it wa placed in the oven. Preliminary sampling ha indicated that wrapped specimens would nc lose moisture during a 1-week period.

For each tree, a weighted moisture pe centage (dry weight basis) was determined fc stemwood, stem bark, branchwood, branc bark, stem (wood and bark combined), an branch (wood and bark). For each type c tissue, a total green weight was obtained b summing the green weights of the samples i that category; total ovendry weight wa obtained in a like manner and moistur percentage computed. Tree moisture wa determined by weighting the stem and branc moisture percentages by their respective gree weights, which were obtained in the fiel when the tree was felled.

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TABLE 1. – *MC (with standard deviation in parentheses) of 6-inch hardwoods growing on southern pine sites*[1].

Species	Species code	Tree	Stem	Stem wood	Stem bark	Branch wood	Branch bark	Branch
					Percent			
White ash (*Fraxinus americana* L.)	WA	51.0 (3.2)	50.5 (3.3)	47.5 (3.1)	68.4 (11.4)	46.1 (4.1)	77.9 (8.6)	54.7 (4.3)
Green ash (*F. pennsylvanica* Marsh.)	GA	51.9 (4.2)	51.4 (4.2)	47.4 (3.9)	77.2 (10.2)	46.9 (3.7)	86.0 (10.2)	55.6 (3.9)
Hickory, true (*Carya spp.*)	Hi	54.8 (3.6)	55.6 (3.9)	51.5 (3.0)	72.9 (10.5)	48.4 (4.0)	84.6 (10.8)	57.1 (3.8)
White oak (*Quercus alba* L.)	WhO	60.8 (5.8)	61.4 (5.1)	61.9 (5.0)	58.1 (8.5)	58.1 (4.5)	70.0 (8.8)	61.5 (4.8)
Post oak (*Q. stellata* Wangenh.)	PO	62.0 (6.0)	62.0 (5.8)	65.6 (6.0)	48.9 (9.4)	60.7 (6.7)	65.1 (12.0)	61.9 (7.7)
Cherrybark oak (*Q. falcata* var. *pagodaefolia* Ell.)	ChO	63.7 (4.6)	64.3 (4.8)	66.6 (6.3)	54.1 (4.2)	55.9 (4.3)	68.2 (3.6)	58.5 (3.9)
Blackjack oak (*Q. marilandica* Muenchh.)	BjO	64.4 (3.8)	65.6 (3.8)	74.2 (5.3)	43.6 (6.4)	59.2 (5.1)	56.2 (8.9)	57.9 (3.6)
Black oak (*Q. velutina* Lam.)	BO	65.1 (4.2)	66.2 (4.3)	69.2 (4.8)	54.5 (7.6)	55.7 (4.1)	62.5 (4.0)	57.3 (3.2)
Southern red oak (*Q. falcata* Michx.)	SRO	65.2 (4.9)	66.0 (5.2)	70.1 (4.3)	52.9 (8.1)	57.5 (2.8)	66.6 (6.1)	59.7 (3.3)
Shumard oak (*Q. shumardii* Buckl.)	ShO	65.4 (5.1)	66.2 (5.3)	69.1 (5.8)	52.2 (4.0)	55.4 (5.4)	66.1 (5.9)	57.8 (4.9)
Scarlet oak (*Q. coccinea* Muenchh.)	ScO	65.6 (5.9)	66.6 (5.7)	69.4 (5.1)	55.6 (8.6)	55.2 (7.0)	66.3 (8.7)	57.3 (7.9)
Northern red oak (*Q. rubra* L.)	NRO	66.0 (7.6)	66.8 (8.0)	69.7 (8.1)	55.7 (14.5)	59.2 (7.2)	62.6 (5.6)	60.2 (6.4)
Winged elm (*Ulmus alata* Michx.)	WE	66.5 (4.9)	66.7 (4.9)	65.6 (5.3)	76.0 (7.8)	61.0 (6.3)	79.5 (7.8)	65.3 (5.2)
Water oak (*Q. nigra* L.)	WaO	69.0 (6.1)	69.5 (6.5)	73.2 (6.9)	54.4 (7.0)	61.8 (6.4)	72.9 (8.1)	64.0 (5.6)
Red maple (*Acer rubrum* L.)	RM	70.3 (6.3)	68.8 (6.5)	69.9 (2.9)	74.4 (2.6)	75.1 (7.2)	89.4 (6.9)	78.2 (6.1)
Hackberry (*Celtis spp.*)	Ha	70.4 (6.7)	70.5 (5.9)	72.6 (6.3)	55.5 (6.1)	64.0 (7.6)	71.7 (8.7)	68.6 (12.8)
Laurel oak (*Q. laurifolia* Michx.)	LO	70.9 (5.0)	71.9 (5.0)	74.4 (5.2)	57.4 (6.3)	61.4 (3.9)	76.0 (6.6)	64.2 (3.7)
American elm (*U. americana* L.)	AE	75.6 (6.4)	77.1 (6.4)	75.5 (7.5)	86.9 (7.7)	64.9 (7.6)	97.8 (6.8)	71.9 (5.8)

Continued next page

TABLE 1. – *MC (with standard deviation in parentheses) of 6-inch hardwoods growing on southern pine sites*[1].–*Continued.*

Species	Species code	Tree	Stem	Stem wood	Stem bark	Branch wood	Branch bark	Branch
Black tupelo (*Nyssa sylvatica* Marsh.)	BT	85.0 (7.7)	85.7 (8.0)	90.0 (9.7)	69.8 (16.9)	88.0 (11.7)	88.4 (12.8)	87.8 (11.1)
Sweetbay (*Magnolia virginiana* L.)	SB	101.2 (7.0)	101.1 (6.5)	100.8 (6.6)	104.6 (14.0)	99.4 (13.1)	100.6 (13.0)	99.9 (11.7)
Yellow-poplar (*Liriodendron tulipifera* L.)	YP	113.4 (7.7)	113.4 (8.2)	111.7 (9.7)	125.8 (23.9)	105.3 (8.6)	134.4 (14.3)	111.6 (5.8)
Sweetgum (*Liquidambar styraciflua* L.)	SG	115.3 (9.7)	116.0 (10.6)	120.4 (12.0)	89.3 (9.9)	108.8 (5.3)	106.9 (8.2)	108.5 (3.3)

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

Results and Discussion

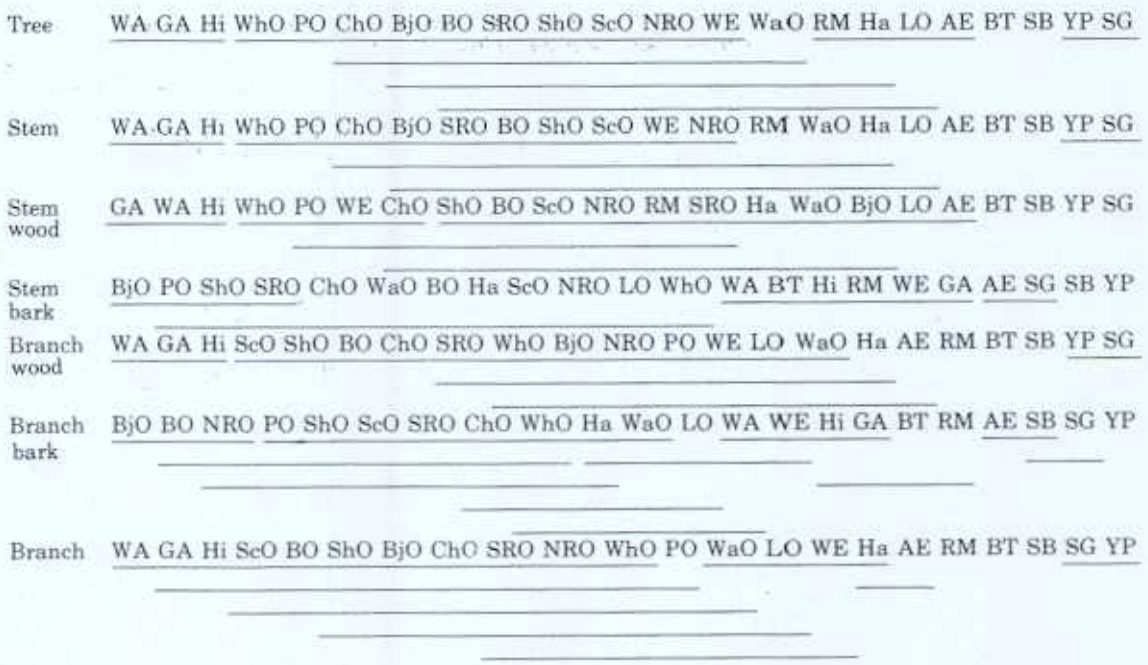
Species are arranged in Table 1 by increasing tree MC. They were also compared for each portion of the tree for which MC was determined. Comparisons, presented on the next page, were made at the 0.05 significance level with Duncan's multiple range test. Species underscored by the same line are not significantly different (for species codes see Table 1). Moisture increases percentage-wise from left to right.

For all portions of the tree except stem bark and branch bark, species ranking followed a similar pattern. For tree, stem, stemwood, branchwood, or branch, the ashes and hickory were lowest (but not significantly so for branches), their MCs ranging from 46 percent for white ash branchwood to 57 percent for hickory branches. Intermediate were the 11 oak species, red maple, hackberry, and the two elms, with values of 55 (branchwood of Shumard and scarlet oak) to 78 percent (red maple branches). Of these intermediate species, American elm was consistently highest, while the two white oaks measured (white and post oak) were lowest in tree, stem, and stemwood moisture. There were significant differences among species within each of these tissue types in the intermediate moisture category. Moisture percentages were successively higher in black tupelo (85 for tree to 90 for stemwood), sweetbay (99 for branchwood to 101 for stem, tree, and stemwood), and finally yellow-popl and sweetgum (105 in yellow-popl branchwood to 120 in sweetgum stemwoo the latter two differed significantly only stemwood moisture.

Bark MC's were lowest in the oaks ar hackberry – with means ranging from 44 to percent in the stem and 56 to 76 for branc material. In the intermediate range were t ashes, winged elm, black tupelo, hickory, ar red maple; in this group, MCs ranged from to 77 percent in stem bark and 80 to 89 perce in branch bark. American elm, sweetgum, ar sweetbay contained significantly higher ba moisture, the range being from 87 to 1 percent in the stem and 98 to 108 percent the branches. Yellow-poplar, with 134.4 p cent in branch bark and 125.8 percent in ste bark, contained more bark moisture than ar other species tested.

MCs of the seven tissues were al compared at the 0.05 significance level with each species. Only for sweetbay were t seven values found to be statistically simil at approximately 101 percent. In black tupel only stem bark MC, averaging 70 percent, w significantly lower than the other categori which contained 85 to 90 percent moisture.

Because of the preponderance stemwood – 74 percent of total tree weig when species were averaged – differenc among stemwood, stem, and tree moistu occurred in only a few species. Stem ba



averaged 14 percent, branchwood 10 percent, and branch bark 2 percent of the tree. Stemwood MC was significantly higher than that of the tree (but not the stemwood plus bark), however, in black, scarlet, Shumard, and laurel oaks; the difference averaged 3.8 percentage points. Stemwood averaged 4.5 percentage points higher than that of stem and tree (which did not differ from each other) in southern red oak and 9.2 percentage points higher in blackjack oak.

In two species (red maple and sweetbay) stem bark and stemwood MCs did not differ significantly. Stem bark MC was significantly higher in six species: hickory, yellow-poplar, the ashes, and the elms. The difference ranged from 10.4 percentage points in winged elm to 29.8 in green ash. MC of stem bark was significantly lower than that of stemwood in the remaining 14 species: sweetgum, black tupelo, hackberry, and the 11 oaks. The difference ranged from 3.8 percentage points in white oak to 31.1 in sweetgum.

In the top, bark and wood MC did not differ in six species; sweetgum, black tupelo, post oak, sweetbay, northern red oak, and blackjack oak. In the remaining 16 species bark MC was greater, the difference ranging from 6.8 percentage points in black oak to 39.1 in green ash.

In the majority (17) of the species, branchwood and branch moisture percentages did not differ significantly. Wood MC was 4.3 percentage points lower in winged elm, 7.0 lower in American elm, and approximately 8.7 lower in hickory and the ashes.

Branchwood MC was significantly lower than that of stemwood in 15 species: sweetgum, the elms, hackberry, and the 11 oak species. It ranged from 4.6 percentage points lower in winged elm to 14.2 lower in scarlet oak. In the remaining seven species branchwood and stemwood MCs did not differ.

Stem bark MC averaged lower than that of branch bark in 19 of the 22 species, the difference ranging from 8.0 percentage points in black oak to 18.6 in laurel oak. The three species having no difference were yellow-poplar, sweetbay, and winged elm.

When stem and branch MCs were compared, the nine species of the red oak group (i.e., all but white and post oaks) were found to have a lower branch MC, the difference ranging from 5.5 percentage points in water

oak to 9.3 points in scarlet oak. Only in red maple was the branch MC more than that of the stem (by 9.3 percentage points). In the other 12 species, stem and branch MC did not differ significantly.

These 220 trees were felled between July 28 and December 19, 1972. Gibbs (1958), in a summary of his work with a number of northern hardwood species, found that MC of both wood and bark varied seasonally, being high at leaf-opening and low in fall. Information on MC or its seasonal variation in southern hardwoods is much more limited. Henderson and Choong (1968) found that standing sweetgum trees in Louisiana differed significantly both with season and with geographical location, but not among sites; there were also significant interactions. The trees reached their highest average MC during the summer (121.3 percent in July) and the lowest in fall (91.7 percent in October). However, Smith and Goebel (1952), studying five species of hickory, detected no seasonal variation in either sapwood, which averaged 51.0 percent MC, or heartwood, which averaged 70.5 percent MC. Working with yellow-poplar, Phillips and Schroeder (1973) found no seasonal trend for either sapwood, heartwood, or stemwood, which averaged 102.6 percent. Bark MC was low in October (92.6 percent) and significantly higher in August (123.4 percent).

The trees in the present study were from a wide range of pine sites and were not collected to determine seasonal trends in MC. In many species, among-tree variation was large enough to mask any trends during the period in which samples were collected.

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