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Potential of two processing methods to reduce sweetgum and sassafras lumber defects

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Sassafras and sweetgum logs were grade sawn and the lumber milled to 4/4 thickness and processed according to two methods. One half of the boards of both species were ripped prior to drying and the other half were dried prior to being ripped to the desired dimension. A statistical analysis revealed that the non-conventional method gave a significantly greater twist, crook, and crook per foot than the conventionally processed boards for both species. Sassafras boards produced with the non-conventional method had significantly higher bow and bow per foot than conventionally processed boards. It is emphasised that our non-conventional method did not follow the Saw-Dry-Rip (SDR) methodology.

Auswirkungen zweier Methoden zur Verringerung von Trocknungsschäden bei Schnittholz aus Amberbaum und Sassafras (Fenchelbaum)

Rundholz von Sassafras und Sweetgum wurden zu 4/4-Brettern aufgeschnitten und abgerichtet und dann nach zwei Methoden weiterbehandelt. Eine Hälfte der Bretter von beiden Holzarten wurde vor dem Trocknen zugerichtet, die andere Hälfte zuerst getrocknet und dann auf die gewünschten Dimensionen zugerichtet. Die statistische Auswertung ergab, daß die nicht-konventionelle Methode erhöhte Anteile an Verdrehung und Krümmung verursachte als bei den konventionell behandelten Brettern zu beobachten war. Sassafrasholz wies nach der nicht-konventionellen Behandlung einen deutlich höheren Anteil an Längsverwerfungen auf als nach konventioneller Methode. Es soll noch darauf hingewiesen werden, daß diese nicht-konventionelle Methode nicht dem Schema der SDR-Methode folgt (Saw-Dry-Rip).

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1 Introduction

Louisiana has a great hardwood resource, although harvest is encroaching on growth. However, the development of the hardwood forest products industry has traditionally lagged behind the softwood industry. While southern yellow pine sawlogs can be grown in 20–25 years on some Louisiana sites, it often takes twice this long to yield hardwood sawlogs on most Louisiana sites.

Two under-utilised hardwoods in Louisiana, and in the entire South, are sassafras (*Sassafras albidum* Nutt.) and sweetgum (*Liquidambar styraciflua* L.). There is a total of 10.1 and 1812.6 million cubic feet of standing timber in Louisiana of sassafras and sweetgum, respectively (Vissage et al. 1991). Sassafras wood is very durable and often is mixed with black ash (*Fraxinus nigra* Marsh.). Sassafras, a pioneer species, may be of greater importance in the future because it rapidly restocks abandoned farm lands (Harlow et al. 1979). Sweetgum is one of the most widespread trees in the southern forest and one of the more important commercial hardwoods in the United States (Harlow et al. 1979).

An increase in defect free southern hardwood lumber production would likely come from improved drying of random width 4/4 lumber. Therefore, the objectives of this study were to (1) investigate the drying defects (crook, bow, and twist) of sweetgum and sassafras lumber produced from both a non-conventional method and a conventional process, (2) determine if there is a difference in final width dimension and moisture content (MC) of non-conventionally processed boards and conventionally processed boards. One-way analysis of variance was performed on each dependent variable to determine significant differences at ($\alpha = 0.05$ between the two drying processes.

Many investigations to reduce lumber drying defects have been conducted using the Saw-Dry-Rip (SDR) process. Although this study did not use SDR, it is similar in that boards were dried before being ripped to dimension. However, the boards for this study were sawn by a grade sawing method instead of being live sawn without edging as is done when using the SDR method. It is therefore emphasised that the non-conventional method employed in this study differed greatly from the SDR process and consequently our method of drying before ripping is simply termed as a "non-conventional method." Our non-conventional method was designed because (1) lumber recovery in terms of quantity and quality was increased by allowing the sawyer to rotate the log, (2) 4/4 hardwood lumber is more common in the domestic market than the 7/4 studs produced by SDR, (3) the 4/4 lumber thickness allowed for more boards to be produced and measured for drying defects.

2
Literature review

A literature review of non-conventional methods to reduce lumber drying defects is basically a review of past SDR investigations. The SDR process for manufacturing structural lumber (studs) from hardwoods has shown great potential for providing a quality product, reducing shipping costs, and relieving pressure on the softwood resource (Meaglin and Boone 1983). The SDR process rearranges the traditional order of lumber manufacturing to account for wood structure and stresses (Hallock and Bulgrin 1977, Maeglin et al. 1988). Conventional manufacturing cuts the lumber to dimension, with an allowance for shrinkage and planing, before drying. The SDR process allows small logs to be live sawn into 7/4 flitches then lightly edged, kiln-dried, ripped to dimension, and finally planed to finished size.

The SDR process has traditionally been employed with low density hardwoods such as yellow-poplar (Boone and Meaglin 1980), red alder (Layton et al. 1984, 1986) aspen (Maeglin 1989). However, denser species such as paper birch (Larson et al. 1986) and red maple (Meaglin and Boone 1985) have yielded favourable results using SDR. Meaglin et al. (1986) have successfully used SDR to produce southern red oak, sweetgum, and blackgum squares. These researchers did have severe honeycomb and collapse in the red oak and in some sweetgum heartwood. Lumber was milled to 13/4 thickness and was ripped to square dimensions (width and thickness) after kiln-drying

Research at the Forest Products Laboratory (FPL) and elsewhere, has shown that it is possible to reduce the amount of warp in lumber using the SDR method (Huber et al. 1984, Larson et al. 1986, Layton et al. 1984, Meaglin and Boone 1985). Research at the FPL has shown that low-grade Great Lakes hardwoods such as aspen (Meaglin 1989) and birch (Erickson et al. 1986) can be produced with less warp through non-conventional methods and thus be made more favorable for structural lumber applications. With regards to western hardwoods, Layton et al. (1984, 1986) have shown that SDR can improve red alder lumber by reducing warp. In the Midwest, Meaglin and Boone (1988) found the SDR method to improve the quality of random-length yellow poplar 2 × 4's harvested from Indiana.

However, SDR research on the vast southern hardwood resource is less thorough. One study has investigated the use of the SDR method to produce southern red oak, sweetgum, and blackgum squares. The SDR method significantly reduced crook, twist and bow in turning squares (Meaglin et al. 1986). However, this study compared SDR to vacuum-dehumidification drying instead of a conventional dry kiln schedule. Also, the final product of the study was turning squares and not structural lumber.

This research into reducing drying defects of sweetgum and sassafras lumber is intended to guide further endeavours to reduce overall hardwood drying defects. Therefore, research concerning the effect of non-conventional methods to reduce the drying defects of sweetgum and sassafras lumber is novel since it is lacking from the literature.

3
Materials and methods

Two sweetgum (*Liquidambar styraciflua* L.) and two sassafras (*Sassafras albidum* Nutt.) trees were felled in the winter from a rolling, upland site with sandy-loam soil in Livingston Parish, LA. Specific information on the trees is available in Table 1. All trees contained straight boles with no visual defects. The trees were bucked into 8-foot logs and milled for optimal grade on a portable Wood-Mizer bandsaw mill. We recovered 129 sassafras boards and 147 sweetgum boards. Green boards were immediately treated with a brush-applied anti-sapstain preservative and end-coated.

Table 1. Basic tree volume information
Tabelle 1. Daten zu den Baumstämmen und Ausbeuten

Species	Tree # – dbh (in.)	# 8 foot logs	Board feet[1]
Sassafras	Tree #1 – 22	2	295
	Tree #2 – 18	1.5	132
			427 (total)
Sweetgum	Tree #1 – 24	2	216
	Tree #2 – 23	2	195
			411 (total)

[1] Doyle log rule based on tree form class 78

Green boards were separated into four groups. Half of the boards from each species were processed by either (1) conventional method or (2) non-conventional method. The conventionally and non-conventionally processed boards were dried with separate kiln charges. All sassafras boards were dried according to the T8-B4 schedule and the sweetgum boards with the T12-F5 schedule (USDA 1991). The conventional method boards were edged and ripped to 2 1/8 in. widths before kiln drying and planed to 7/8 in. thickness after kiln-drying, and the non-conventionally dried boards were dried in random widths in the charge and then ripped to 2 1/16 in. widths and planed to 7/8 in. thickness after kiln-drying. These boards were ripped to yield the best quality from the random width boards. Therefore, all boards could theoretically have a final width of 2 in. if they were to be moulded or dressed. Each charge was dried to a target MC of 8% (±2% in an Irvington Moore model MDK-365-R dry kiln with approximately 500 board feet capacity. Kiln conditions were maintained within ± 3 °F.

The drying defects that were measured included crook, bow, and twist. Crook and bow readings were recorded every linear foot. Bow per foot and crook per foot mean values are indicators of the variability in bow and crook, respectively, along the lengths of the boards. Bow per foot and crook per foot is the summation of all bow and crook values, respectively, for an individual board divided by the total length of that board. All recordings were obtained with a digital caliper to the nearest 0.0001 in.

4
Results and discussion

The mean values of each measured drying defect, width, and MC for sassafras and sweetgum lumber processed by the non-conventional method and conventional methods are shown in Table 2. The non-conventional method failed to reduce drying defects for sassafras lumber. In fact, the non-conventional method sassafras boards contained a significantly higher amount of every drying defect.

The non-conventional method also yielded less favorable results than the conventionally processed boards for sweetgum. The sweetgum non-conventional method boards contained significantly higher twist, crook, and crook per foot than the conventionally processed boards, even though there were a much greater number of the conventionally processed boards that were drying defect free (Table 3). The non-conventional method boards also

Table 2. Mean values and level of significance (P value) of each dependent variable comparing sassafras and sweetgum lumber processed by a non-conventional method and a conventional method
Tabelle 2. Mittelwerte und Vertrauensbereich der einzelnen Parameter beim Vergleich der beiden Methoden zur Behandlung von Schnittholz aus Sweetgum (Amberbaum) und Sassafras (Fenchelbaum)

Dependent variable	Non-conventional Method	Conventional Method	P value
Sassafras			
Width (in.)	2.0375[1] (0.0265)[2]	2.0437[3] (0.0100)	0.0927
Bow (in.)	0.2612 (0.1789)	0.1872 (0.1166)	0.0065**
Bow per foot (in./ft.)	0.0732 (0.0539)	0.0553 (0.0374)	0.0299*
Moisture content (%)	7.8053 (0.9672)	7.3634 (0.4702)	0.0014**
Twist (in.)	0.1034 (0.0742)	0.0786 (0.0548)	0.0328**
Crook (in.)	0.3077 (0.2484)	0.1881 (0.2121)	0.0040**
Crook per foot (in./ft.)	0.0892 (0.0762)	0.0552 (0.0656)	0.0079**
Sweetgum			
Width (in.)	2.0888[4] (0.0608)	2.0335[5] (0.0141)	0.0001**
Bow (in.)	0.3270 (0.2369)	0.3197 (0.1591)	0.8295
Bow per foot (in./ft.)	0.0459 (0.0387)	0.0549 (0.0283)	0.1124
Moisture content (%)	8.2714 (1.1916)	7.9783 (0.7994)	0.0842
Twist (in.)	0.2104 (0.1459)	0.1635 (0.1183)	0.0348*
Crook (in.)	0.9483 (0.3050)	0.7209 (0.2577)	0.0001**
Crook per foot (in./ft.)	0.2333 (0.0900)	0.1771 (0.0686)	0.0001**

[1] Represents the average of 66 samples
[2] Numbers in parenthesis are standard deviation
Note: **Denotes significance at $\alpha = 0.01$
*Denotes significance at $\alpha = 0.05$
[3] Represents the average of 63 samples
[4] Represents the average of 76 samples
[5] Represents the average of 71 samples

contained an insignificantly higher degree of bow. The only property in which the non-conventional method boards gave better results than the conventionally processed boards was bow per foot for the sweetgum boards (Table 2).

Table 3 shows the percentage of defect-free lumber for both species and processing schedules. There was little defect-free material produced, with the exception that 15% of the sweetgum boards did not show any amount of twist. However, more twist-free sassafras and bow-free sweetgum was produced using the conventional method.

These results are in disagreement with numerous previous studies that adhered to the SDR method. The boards for this study were not live-sawn but rather were grade sawn. The SDR method calls for boards to be live-sawn and consequently these boards should have more defects influencing drying degrade which can later be excluded by selective ripping. Perhaps, by grade sawing the lumber, not enough defects effecting drying degrade were obtained to show any benefit of ripping after drying. It appears, then, that any reduction of drying defects can be attributed to the drying schedule rather than the milling method.

Case-hardening was monitored and tested for on sample boards during the equalizing phase of drying. None of the sample boards exhibited any signs of case-hardening when tested. Although not an integral part of this study, case-hardening will not directly affect the lumber until it is ripped or milled after drying. This milling can unbalance the stresses in each board and subsequently cause warp.

Also, the typical SDR method process is done with 7/4 flitches. All boards in this study were milled to 4/4. The 4/4 boards do not typically develop severe drying stresses as found in 7/4 lumber because of the relative similarity of face and core MC's and thus minimal compressive and tensile internal stresses. Therefore, it appears there is less to gain by using the non-conventional method with 4/4 boards. This could also be explained by the grade-sawing method which may have eliminated any large knots and other defects before drying that could account for some of these drying defects, which could ultimately reduce the benefit of drying before ripping.

5
Conclusions

Based on this research our non-conventional method is not a favorable method of producing either sassafras or sweetgum 4/4 lumber. Further research with 7/4 or thicker live-sawn lumber is recommended in order to determine the advantage of drying before ripping for both species. Also, since 4/4 lumber is the most common hardwood lumber size in the US, further research with 4/4 lumber is necessary.

It was also found that differences between grade-sawing and live-sawing should be measured during processing to

Table 3. Percentage of sassafras and sweetgum lumber that was produced defect-free according to the conventional and non-conventional methods
Tabelle 3. Anteil an Fehlerfreiem Schnittholz von Sassafras (Fenchelbaum) und Sweetgum (Amberbaum), das nach Auswertung beider Methoden

Defect	Sassafras		Sweetgum	
	Conventional Method	Non-conventional Method	Conventional Method	Non-conventional Method
Bow	2	2	0	4
Crook	5	5	0	0
Twist	3	5	15	4

account for possible differences in defect location and size. The unknown influence of case-hardening on the study should also be measured to make better inferences on the material.

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