The Effect of Tree Espacement upon Wood Density in Sitka Spruce

(Pices Sitchensis (Bong.) Carr.)

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The influence of planting espacement on the growth and wood properties of Sitka spruce has become a subject of much interest in Ireland. Initial espacement has increased gradually and nowadays plant density is normally about 2000-2500 plants per hectare. Wider planting espacement is attractive because it postpones early thinning and results in bigger poles at first thinning. Wide initial espacement plus fertiliser application has resulted in faster grown Sitka spruce trees. Many foresters are concerned that the wood produced by these trees may be so low in wood density as to make it too weak for many load bearing uses.

This paper describes the effect of initial spacing on wood density and the relationship between ring width and wood density, in a young Sitka spruce plantation.

Materials and Methods

Wood samples were obtained from the Forest and Wildlife Service spacing trial 11/63 at Doneraile Forest, Co. Cork, which was established in 1963 on a gleyed soil. The design of the experiment was a randomised block with four replications and five spacing treatments. The spacings were 1.2m x 1.2m, 1.8m x 1.8m, 2.4m x 2.4m, 3.0m x 3.0m and 3.6m x 3.6m. Each plot was provided with a surround and the treatments were continuous into the surround. The expected yield class of the site is 26. In 1972 the trees planted at 1.2m spacing closed canopy and the trees planted at 2.4m x 2.4m closed canopy in 1975. The trees planted at 3.0m apart have only recently formed a full canopy.

For the purpose of this experiment the Forest and Wildlife Service permitted the felling of a limited number of trees from the surround areas. Sample trees were chosen on the basis of the mean

diameter at breast height in the selected spacings. In November 1981, eight sample trees were felled from the surrounds of the 1.2m, 2.4m and 3.0m espacements. Due to the small numbers of trees in the 3.6m plots, it was considered undesirable to fell trees from this espacement. The selected trees ranged in height from 10.2m to 14.8m. After felling, discs approximately 2.0cm wide were removed from each tree at heights corresponding to 3.5%, 15%, 30%, 45%, 60% and 80% of total height. Ring widths were read directly from these by passing each disc, on a graduated moving stage, under the cross hair of a Digital Positiometer. Readings were taken along two diameters at right angles to each other. This gave four readings for each annual ring. The discs were then sawn on a small bandsaw, (kerf width 0.75mm), to give two semi-circular segments and a rectangular section which boxed the pith. From this latter section groups of annual rings were split off for wood density determination. Wood density was determined by the water displacement method of Olesen (1971). Approximately twenty-five measurements were taken per tree.

RESULTS

Mean wood density values per espacement are given in Table 1. Although there appears to be considerable variation within treatments, statistical analysis showed that the mean wood density variance was constant for each treatment. Analysis of variance showed no effect of spacing upon mean wood density.

Table 1: Mean Wood Density (gm/cc) by Spacing

Block No.	Espacement (m)		
	1.2	2.4	3.0
I	0.3321	0.3381	0.3340
II	0.3565	0.3171	0.3326
III	0.3873	0.3191	0.3606
IV	0.3949	0.3580	0.3614
$\bar{X}$	0.3677	0.3331	0.3471

Analysis of Variance

Source	S.S	D.F.	M.S.	F. Ratio
Blocks	0.002807	3	0.000935	
Spacing	0.002425	2	0.001212	4.62
Residual	0.001574	6	0.000262	
Total	0.006806	11		

Tabulated F.05 (1), 2,6=5.14

In view of the manner in which the trees at the various espacements closed canopy, it appeared reasonable to seek differences in mean wood density of the wood in the nine outer rings and below 45% of total height were examined (Table 2). Analysis of variance showed that there were significant differences in the mean density of the wood formed at the various espacements during the period mentioned.

Table 2: Mean Wood Density (gm/cc) in the Nine Outer Rings Below 45% of Total Height.

Block No.	Espacement (m)		
	1.2	2.4	3.0
I	0.3260	0.3066	0.2928
II	0.3348	0.3312	0.2991
III	0.3807	0.3220	0.3291
IV	0.3714	0.2950	0.3285
$\bar{X}$	0.3532	0.3137	0.3124

Analysis of Variance

Source	S.S	D.F.	M.S.	F. Ratio
Blocks	0.002035	3	0.000678	
Spacing	0.004310	2	0.002155	6.45
Residual	0.002004	6	0.000334	
Total	0.008349	11		

Tabulated F.05 (1), 2,6=5.14

A multiple range test showed that the wood formed in the trees spaced at 1.2m was denser than that formed in trees spaced at 2.4m or 3.0m. No significant difference in mean wood density could be found between the trees planted at 2.4m and 3.0m (Table 3).

Table 3: Multiple Range Test for Mean Wood Density in Nine Outer Rings Below 45% of Total Height.

Spacings	Diff.	S.E.	Calculated Q	P.	Tabulated Q
1.2 and 3.0	0.0408	0.00914	4.46	3	4.33
1.2 and 2.4	0.0395	0.00914	4.32	2	3.46
2.4 and 3.0	0.0013	0.00914	0.14	2	3.46

q=0.05

Simple linear regression analysis was used to examine the relationship between ring width and wood density (Table 4). The correlation co-efficient between the two sets of data was — 0.35. This indicated that a weak negative association existed between wood density and ring width.

Table 4: Original Data for Mean Ring Width and Mean Wood Density.

Espacement (m)	Mean Ring Width (mm) per tree	Mean Wood Density (gm/cc) per tree
1.2 x 1.2	3.6051	0.3293
	3.7388	0.3350
	3.4450	0.3870
	3.1471	0.3261
	3.4878	0.3757
	3.7655	0.4142
	3.4736	0.4119
	4.1965	0.3627
2.4 x 2.4	6.1038	0.3532
	5.0741	0.3231
	6.1873	0.3527
	6.3755	0.3633
	6.3758	0.3155
	6.9401	0.3193
	6.8586	0.3279
	6.9116	0.3102
3.0 x 3.0	6.9651	0.3451
	7.4486	0.3760
	7.0633	0.3967
	6.7820	0.3261
	8.1185	0.3236
	7.1758	0.3415
	8.4660	0.3582
	7.2996	0.3096

DISCUSSION

Evidence from the literature suggests that increased planting espacement results in a reduction in wood density (Gardiner and O'Sullivan, 1978: Cown, 1974). Such an effect could not be demonstrated in this study. The sample mean difference in wood density between trees planted at 1.2m and 3.0m spacing was .0206 gm/cc. This indicates a 'fall-off' in wood density of 9.9% at the wider espacement. This is a relatively small reduction in wood density and the number of samples necessary to detect differences of this magnitude have been found to be quite large (Cown, 1974). A similar reduction in density in the wood formed in the lower portions of the stems during the time interval between canopy closure at the narrowest and widest espacements was found to be statistically significant. Thus small reductions in wood density due to spacing probably persist for a short period only. When canopy closure occurs at the wider espacements it seems likely that differences in wood density will even out. It would, therefore, seem that low wood density will not be a critical factor in the degrade of timber grown at initial espacements up to 3m. Other factors which contribute to overall wood quality, such as knot size and the volume of juvenile wood are also adversely influenced by wide espacement. These factors may have a greater influence upon wood utilisation than small reductions in wood density.

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