The Effect of Wide Espacement on Wood Density in Sitka Spruce

(Picea Sitchensis. (Bong.) Carr)

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IN modern plantation forestry wide espacement is attractive because it leads to lower establishment costs, it dispenses with uneconomic thinnings, it gives greater individual tree vigour and it concentrates the final volume production on a smaller number of more uniform trees. Numerous reports (Ward and Gardiner, 1976; Brazier, 1970; Cown, 1973) have suggested that one of the effects of vigorous tree growth is to cause a decrease in wood density as vigour of growth increases. The evidence for this is, however, conflicting since some investigators (Maeglin, 1967; Paul, 1963) have reported that within the limits of normal silvicultural practice, initial spacing has very little effect on the density of the wood produced. Furthermore, it has been shown (Larson, 1969) that when species such as pines and spruces are pruned artifically, they produce wood of a non-uniform quality, characterised by a rapid increase in latewood percentage with increasing age.

This report gives some results of a study carried-out in two stands of Sitka spruce *(Picea sitchensis* (Bong.) Carr) with very wide planting espacement, and shows the distribution of density variation in trees with artifically reduced crowns.

Materials and Methods

The spruce stands from which the samples were taken were located at Drumhierney Plantations, Co. Leitrim. They were established in 1954 at spacings of 2.4mx2.4m and 4.5mx4.5m respectively.

Neither stand has been thinned since establishment but all of the stems in both crops have been consistently pruned from an early age to leave approximately $\frac{1}{3}$ of the live crown. The trees in the more widely spaced stand are just closing canopy but there is fairly intense competition amongst trees in the stand established at 2.4mx2.4m. Further particulars of these stands are given in Table 1.

Eight trees were sampled in each stand. Sample trees were located by dividing the stems into four diameter classes and randomly selecting two trees within each class. Each selected tree was climbed and a 5mm core was taken at heights corresponding to 10%, 25%,

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TABLE 1
Some Characteristics of two Sitka spruce stands at Drumhierney Plantations, Co. Leitrim

	STAND 1	STAND 2
Soil Type	Surface Water Gley	Surface Water Gley
Espacement	2.4mx2.4m	4.5mx4.5m
Age	23 years	23 years
B.A. per ha	54.5m²	27.9m²
Top Height	17.5m	16.0m
Mean D.B.H.	22.75 cms.	28.63 cms.

40% and 60% of the total height. A core was also taken at breast height. All cores were taken on the south side of the trees. Whole core density was determined using the water displacement method. The mean wood density as derived from four cores was compared with wood density as estimated from one core taken at breast height.

Results

The estimates of wood density obtained from single cores taken at breast height were in almost all cases greater than those obtained from 4 cores taken at various heights in the stems (Table 2). The correlation coefficients were 0.946 and 0.896 for the 2.4mx2.4m and 4.5mx4.5m stands respectively. The overall correlation coefficient for both stands sampled was 0.934. These coefficients were found to be significant at the 1% level. Statistical analysis also showed that there was a significant
difference (1% level) in mean wood density between the samples taken from trees established at 2.4mx2.4m and those established at 4.5mx4.5m (Table 3).

The pattern of wood density variation was also traced and compared in three sequences for each of the stands (Figs. 1, 2, 3).

While the characteristic patterns of density variation were apparent, the differences in estimated wood density between the two stands did not appear to be located in any specific area in the trees but was found to be evenly distributed throughout the stems. The density of the wood from the 4.5mx4.5m stand was found to be at all heights and in each sequence, lower than that of the 2.4mx2.4m stand.

Discussion

Although increment cores have been used to give estimates of wood density in standing trees for many years, there is very little

TABLE 2
A comparison of mean density of 16 trees as calculated from 4 cores and density of the same trees as estimated from 1 core taken at breast height.

2.4mx2.4m Spacing

Tree No.	Mean Density from 4 cores (gm/cc)	Density from 1 core (gm/cc)
1	0.3798	0.3915
2	0.3416	0.3509
3	0.3325	0.3560
4	0.3535	0.3545
5	0.4052	0.4252
6	0.3371	0.3612
7	0.3611	0.3809
8	0.3440	0.3566

4.5mx4.5m Spacing

Tree No.	Mean Density from 4 cores (gm/cc)	Mean Density from 1 core (gm/cc)
1	0.2912	0.2842
2	0.3214	0.3355
3	0.3162	0.3167
4	0.3300	0.3081
5	0.3633	0.4012
6	0.3076	0.3289
7	0.3010	0.3176
8	0.2928	0.3089

information available as to how many cores should be taken and the optimum location of these in the tree. Results obtained in this study indicate that the estimate of wood density obtained from a single increment core taken at breast height is closely related to mean wood density as derived from a series of borings taken at various heights in the stem. Thus, the evidence from this study suggests that whole stem wood density can be accurately predicted using a single 5mm increment core taken at breast height. In addition, examination of the data showed that mean wood density for these stands could be predicted (_+ 10% at the 95% confidence level) by taking borings from seven trees in each stand.

Since the spacings found at Drumhierney plantations were not replicated it was not possible to directly compare wood density

TABLE 3
The estimated wood density in trees planted at wide espacements

Tree No.	Mean Wood Density (g/cc) of 2.4mx2.4m trees	Mean Wood Density (g/cc) of 4.5mx4.5m trees
1	0.3798	0.2912
2	0.3416	0.3214
3	0.3325	0.3162
4	0.3535	0.3300
5	0.4052	0.3633
6	0.3371	0.3076
7	0.3611	0.3010
8	0.3440	0.2928
	$\bar{X}_1 = 0.3569$	$\bar{X}_2 = 0.3154$

$\bar{X}_1 - \bar{X}_2$	=	0.0415 gms/cc
Pooled S^2	=	0.000584
t value	=	3.4326
Probability of Type II Error	=	26%

between the two stands. However, the results indicate that the wood produced at the wider spacing is lower in density than that growing in the 2.4mx2.4m stand. The actual difference found was 0.045 g/cc or 45 kg/m^3. Nevertheless, it appears that the wood produced in these widely spaced stands at Drumhierney compares very favourably, as regards density, with spruce wood produced in plantations managed under more conventional silvicultural regimes (Table 4).

It was not possible to isolate the effect of green pruning upon wood density in this study. However, it is probable that green pruning,

TABLE 4
Wood density in some Sitka spruce plantations in Ireland

Location	Age (yr.)	Yield Class	Density Range G/cc	Mean Density g/cc
*Camolin Forest	44	22	0.29-0.44	0.35
*Aughrim Forest	39	18	0.23-0.45	0.35
*Killarney Forest	48	24	0.28-0.45	0.36
Drumhierney				
2.4mx2.4m	23	24	0.33-0.41	0.36
4.5mx4.5m	23	—	0.29-0.36	0.32

**Sources:* I.I.R.S. Reports, 1, 2 and 3. "The properties of Irish Grown Sitka spruce".

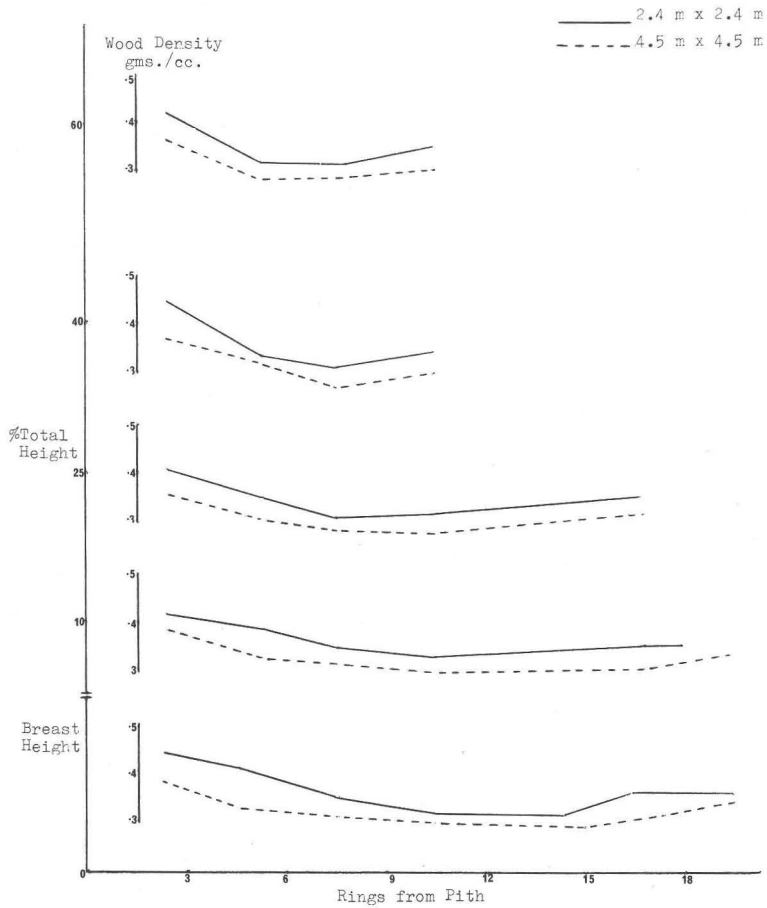

FIG. 1
Wood density variation in the horizontal sequence at five height levels.

which is analogous to artifically creating stand grown trees from open grown trees, was responsible for the even distribution of density variation in the stems of the more widely spaced stand.

In conclusion, it may be said that these results indicate the presence of a significant difference in wood density in the stands examined. However, it does seem that this effect has been modified considerably by the green pruning.

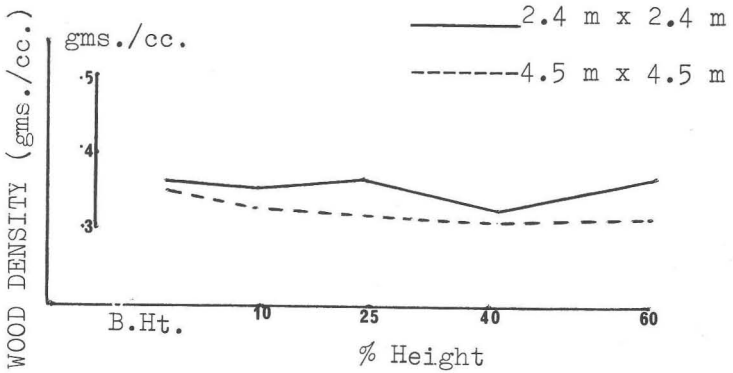

FIG. 2
Wood density variation in the vertical sequence at 10 rings from the pith.

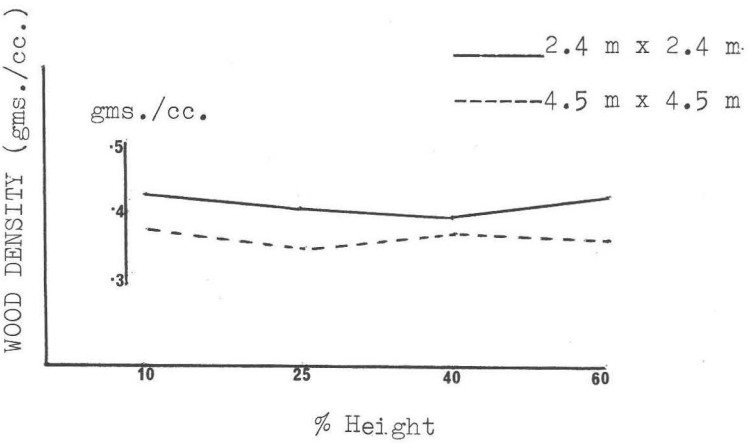

FIG. 3
Wood density variation in the oblique sequence at 10 rings from the bark.

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