Rate of Weight Loss of Small Round Timber

P. S. SAVILL

Northern Ireland Forest Service, Dundonald House, Belfast.

INTRODUCTION

In certain markets for small round wood, purchase by weight is preferred to purchase by solid or stacked volume. Where produce is sold by weight it is desirable to know the relative green weights of different species and also how weight, for a given volume of timber, changes with time as this can influence prices.

Among the relatively limited information on this subject for Northern Irish conditions, Jack (1966), working with Sitka spruce, showed that the rate of weight loss over a 20 week period was linear and was likely to remain so up to the time the material reached a density of about 550kg/m^3. He found large variations in the rate of loss according to the time the material was felled, ranging from 2.7kg/m^3 per day for material felled in April to 0.99kg/m^3 per day for material felled in November. Small sized material lost weight about 50 *per cent* faster than larger sizes. There were small differences in the rate of weight loss of produce from different forests and of different yield classes.

EXPERIMENTAL METHODS

A total of up to 9 billets of timber each 2m long, were cut from two randomly selected trees of each of the 16 species listed in Table 1, in the vicinity of Newcastle, Co. Down, on 9 July 1975, 12 November 1975 and 14 April 1976.

Each piece was weighed on the day it was felled to the nearest 100g and then two and four weeks after felling, and subsequently every four weeks up to the end of about 35 weeks. Billets of all species cut on any one date were stacked parallel to each other in random sequence so that they did not necessarily occupy the same place in the pile after each weighing. They were piled under the shade of some large trees and did not receive any direct sunlight.

The mid-diameter over bark of each billet was recorded to the nearest 0.1cm and its true volume calculated. In subsequent calculation, results were expressed as weights, weight losses, etc. per cubic metre of timber. The volume at the time of first measurement was used throughout; it was not recalculated at each reweighing because mid-diameters, checked on a sample of billets on several occasions, never varied, indicating that over the 35 week period the timber did not dry below fibre saturation point. Small quantities of bark were lost with time from some of the billets but these losses were negligible.

In total, 428 individual pieces of timber were dealt with (16 species x 9 pieces (approximately) x 3 felling times). The average mid-diameter was 16.1cm with a standard deviation of 2.33cm. Thus, over 99% of all the samples had a mid-diameter of the mean $\pm$3 standard deviations. They were therefore within a range of 9.1 — 23.1cm mid-diameter. No piece had a mid-diameter of less than 7cm.

RESULTS

The main results of the work described in this paper are summarised in Table 1. Before discussing them in any detail, it should be noted that the design of this experiment makes it unlikely that differences between species will be particularly consistent, unless they are very large. It is known, for example, that at least among some species, timber properties can vary significantly not only betwen trees from different sites but also within sites, and between, and within provenances. Properties can also vary according to the rate at which a tree grows, the part of the tree from which the timber is cut, and other factors (Elliot 1970). Since only about 9 pieces of timber were used in this experiment from each species at each time of cutting and no regard was taken in the design to account for possible variations of this kind, fairly large variations would be expected.

Density at time of felling[1]

Table 1 shows the green density[2] of the material for the different times of felling in kilograms per cubic metre. It can be seen that on average the timber cut in November had a slightly greater density than that cut in April or July, a finding which is consistent with Jack's (1966) work on Sitka spruce (*Picea sitchensis* (Bong.) Carr). This is not however true of all 16 species. For example, Scots pine (*Pinus sylvestris* L.) scarcely varied at all and European larch (*Larix decidua* Miller), beech (*Fagus sylvatica* L.) and birch (*Betula spp*) were denser in April while lodgepole pine (*Pinus contorta* Dougl.) was denser in July.

1. Samples of sycamore (*Acer pseudoplatanus* L.) were included with the material cut in November and April. Its green density and rate of weight loss were similar to birch.
2. The "green density" figures given in this paper were calculated by dividing the weight, at the time of felling, by the volume at the time of felling. The values obtained by this method are naturally much higher than conventional values for density which are calculated by dividing oven dry weight by volume.

TABLE 1 Summary of Green Densities and Rates of Weight Loss for 16 Species

SPECIES	JULY CUT MATERIAL			NOVEMBER CUT MATERIAL			APRIL CUT MATERIAL			OVERALL MEANS		
	1 Green density kg/m^3	2 Weight loss per day kg/m^3	3 Weight loss in 4 weeks %	4 Green density kg/m^3	5 Weight loss per day kg/m^3	6 Weight loss in 4 weeks %	7 Green density kg/m^3	8 Weight loss per day kg/m^3	9 Weight loss in 4 weeks %	10 Green density kg/m^3	11 Weight loss per day kg/m^3	12 Weight loss in 4 weeks %
SPRUCES												
Norway Spruce	876	1.15	3.51	1 032	1.46	4.21	994	1.76	5.16	976	1.46	4.29
Sitka Spruce	867	1.34	4.10	1 012	1.53	4.49	932	1.59	4.78	937	1.49	4.46
PINES												
Corsican Pine	917	0.79	2.36	927	0.71	2.03	917	0.64	1.97	920	0.71	2.12
Lodgepole Pine	956	1.01	2.98	870	1.13	3.30	855	0.94	2.75	894	1.03	3.01
Scots Pine	972	0.93	2.91	978	0.74	2.22	980	0.59	1.90	977	0.75	2.34
LARCHES												
European Larch	808	0.85	2.43	899	0.68	2.00	940	1.13	3.37	879	0.89	2.60
Japenese Larch	809	0.95	2.81	838	0.90	2.65	819	1.36	4.04	822	1.07	3.17
OTHER CONIFERS												
Douglas Fir	867	0.95	2.83	900	1.14	3.40	845	1.19	3.59	871	1.09	3.27
Noble Fir	958	1.06	3.21	991	1.06	3.09	951	1.27	3.85	967	1.13	3.38
Western Hemlock	894	0.79	2.36	895	1.30	3.95	809	1.32	4.10	866	1.14	3.47
HARDWOODS												
Alder (Common & Grey)	843	1.02	3.07	848	0.95	2.83	804	0.99	2.85	832	0.99	2.92
Beech	1 112	0.59	1.92	1 046	0.76	2.36	1 177	0.61	1.92	1 112	0.65	2.07
Birch	837	0.78	2.26	893	0.71	2.11	953	0.55	1.66	894	0.68	2.01
Eucalyptus SPP	1 092	0.62	1.98	1 096	0.88	2.61	1 045	1.07	3.17	1 078	0.86	2.59
Oak (Sessile)	1 076	0.54	1.74	1 159	0.18	0.94	1 091	0.34	1.26	1 109	0.35	1.31
Poplar (Hybrid)	765	0.88	2.55	769	0.98	2.88	748	0.88	2.52	761	0.91	2.65
Sycamore	—	—	—	845	0.64	2.11	920	0.91	2.76	883	0.77	2.43
MEANS	916	0.89	2.69	946	0.94	2.82	929	1.01	3.06	930	0.95	2.85

Standard errors:		*Species*	*Month*	*Species x Month*	*Residual of*
	Green density (kg/m^3)	15.7***	6.8**	22.2***	380
	Weight less/day (kg/m^3)	0.078***	0.34*	0.135*	378
	Weight less/4 weeks (kg/m^3)	0.227***	0.099*	0.393*	378

Note: **In the analyses of variance for weight less per day and % weight less in 4 weeks the data were adjusted according to the volume of each billet and its fresh weight: these variables were used as convariates. Data for sycamore were not included in any statistical analyses.**

In cases where comparisons are possible, the average green densities found in this experiment (Table 2) are reasonably close to those quoted by Hamilton (1975). Five of the species, including the spruces, are within 2% of Hamilton's figures, 4 are within 4% and a further 5 range between 6 to 8%. The last group includes Corsican and lodgepole pines (*Pinus nigra* Arnold var *calabrica* Schneid.), western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and beech. The density shown for Sitka spruce is also within 3% of Jack's (1966) average figure.

Table 2 — Green densities averaged over all dates of felling in descending order of magnitude.

Species	Average Green density (kg/m^3)	Figures from Hamilton (1975) — kg/m^3
Beech	1,112	1,030
Oak	1,109	1,060
Eucalyptus	1,078	—
Scots pine	977	1,020
Norway spruce	967	960
Noble fir	967	930
Sitka spruce	937	920
Corsican pine	920	1,000
Lodgepole pine	894	950
Birch	894	930
Sycamore	883	830
European larch	879	900
Douglas fir	871	870
Western hemlock	866	930
Alder	832	—
Japanese larch	822	830
Poplar	761	—

Changes in density with time after felling

Calculations for individual pieces and means show that for all practical purposes linear regressions satisfactorily differentiate rates of weight loss over the time periods examined (Fig. 1). For this reason, the regression coefficients for each billet, which represent the weight loss in kilograms per cubic metre per day, were used in an analysis of variance. Means and some statistical details are summarised in Table 1. The relationships between green density and rate of weight loss are also illustrated more simply in Fig. 2. The

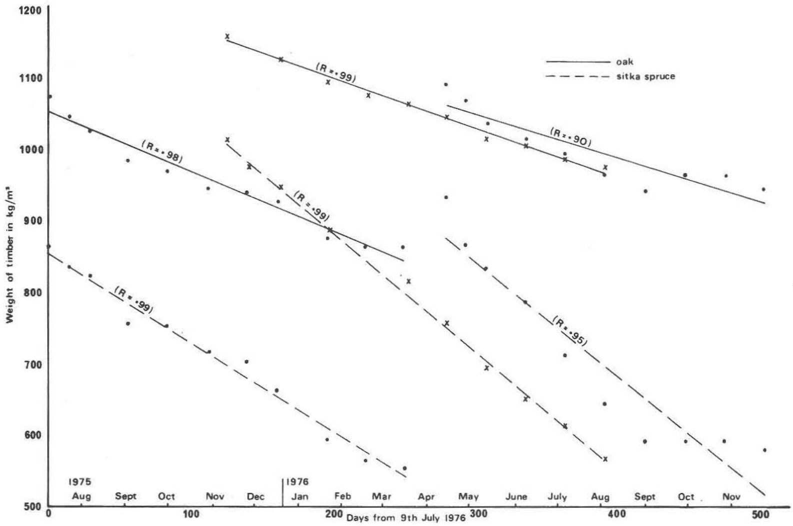

FIG. 1. Rates of weight loss with time and date of felling for Oak and Sitka spruce.

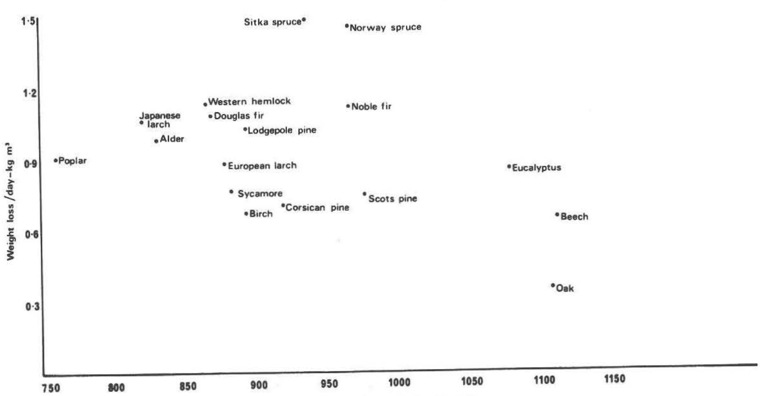

FIG. 2. Relationship between green density and weight loss per day for different species.

average rate of weight loss of the spruces was significantly greater than all other species and oak (*Quercus petraea* Matt.) was significantly slower, based on least significant differences.

Several of the remaining species were reasonably consistent in relation to each other in their rates of drying. However a few anomalies should be noted, one of the most obvious is western hemlock: July cut material dried out significantly more slowly than material cut in the other two periods. The billets of the pines and birch cut in April dried out more slowly than those cut in July or November whereas the overall trend indicated that the reverse should have been true. Similarly, if the July and November cut material is compared, the overall trend indicated that species lost weight more quickly (though not significantly so) in November where as with several species this was not so. These include Corsican and Scots pine, the larches, alder (*Alnus* spp.) and oak. The reasons for these variations are not obvious, but could be associated with variation in the individual trees from which the billets were cut.

The differences in drying rates for the different times of felling are not as great as might have been expected from Jack's (1966) work. His mean figures for weight loss of Sitka spruce were 1.91kg/m^3 per day for July felled material, 0.99kg/m^3 for November and 2.75kg/m^3 for April, representing a maximum difference between July and April of 64%. In this experiment the figures for similar periods were 0.89kg/m^3 per day for July cut material, 0.94kg/m^3 for November and 1.01kg/m^3 for April indicating a maximum difference of only 12%. It is not known why results of the two exercises differ so much, but differences could be associated with variations in climate during the years in question and also the ways in which cut produce was stored.

Differences in the rates of drying are obviously caused by variations in temperature, humidity, wind, precipitation etc, at different times of year and between years. Perhaps the easiest of these climatic variables to record is rainfall and Fig. 3 shows that there was a reasonably good relationship between the average rate of weight loss of all Sitka spruce samples and precipitation during the 28 day period of weight loss, recorded in a rain gauge placed adjacent to the experimental site.

Percentage weight loss with time after felling

For some purposes it is more useful to express rates of weight loss with time as a percentage loss from the original green densities. The percentage loss for each species over 4 week periods are accordingly shown in Table 1. From these data it seems reasonable to group the species as shown in Table 3.

The spruces tend to lose a significantly greater percentage of their weight with time than all other species, and oak loses significantly less. Based on least significant difference calculations, the remain-

Table 3 — Grouping of species according to relative rates of weight loss.

Group	Species	% Weight Loss Per Month
1	Sitka spruce	4.46
	Norway spruce	4.29
	Western hemlock	3.47
	Noble fir	3.38
2	Douglas fir	3.27
	Japanese larch	3.17
	Lodgepole pine	3.01
	Alder	2.92
	Poplar	2.65
	European larch	2.60
	Eucalyptus	2.59
3	Scots pine	2.34
	Corsican pine	2.12
	Beech	2.07
	Birch	2.01
4	Oak	1.31

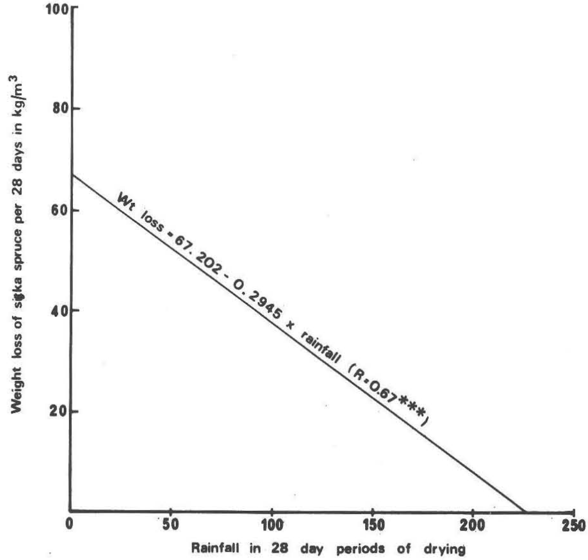

FIG. 3. Relationship between weight loss of Sitka spruce timber and rainfall in preceeding 28 days.

ing 13 species can be divided broadly into 2 groups. Western hemlock, Noble fir, Douglas fir, Japanese larch, lodgepole pine and alder all tend to lose rather a higher proportion of their weight with time than the remaining seven species.

Table 1 shows that material cut in July does not dry out at a significantly greater rate than that cut in November while April cut material dries significantly faster than that cut in either of the other periods. It is probably reasonable to suggest therefore that only two main time periods are likely to cause major variations in the drying rates of timber. The first might include the bulk of the summer months, March — August, and the period September — February is the one when drying is likely to be slower.

Effect of size of material on rate of weight loss

The average billet used in this experiment had a mid-diameter of 16.1cm with the majority of pieces ranging between 9.1 and 23.1cm. It would be reasonable to expect the small diameter pieces which have a large surface area in relation to volume to dry more quickly than large diameter pieces.

To illustrate this, the percentage weight losses per month of each piece of Sitka spruce and oak were computed and regressions against mid-diameter calculated. The results are shown in Fig. 4.

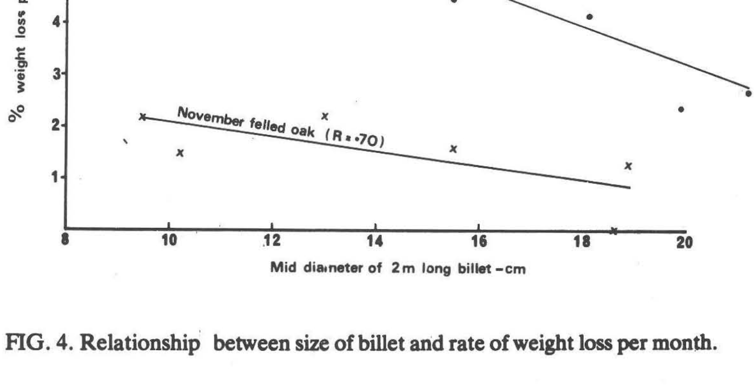

FIG. 4. Relationship between size of billet and rate of weight loss per month.

Linear regressions once again satisfactorily explain differences within the size range of material being examined. With these 2 species of material cut in November, the greatest difference was found with Sitka spruce where 10cm diameter billets lost weight at a rate of 6.8% per month while 20cm diameter material lost it at 3.2% per month. The smallest difference was with oak where, for the same sizes, losses were 2.2% and 1.1% respectively. However, regardless of the percentage weight loss, the 10cm material of both species lost weight at twice the rate of 20cm material.

DISCUSSION

The experiment described here has provided some data for Northern Ireland conditions to show the rates at which small sized timber loses weight according to species, season of cutting and size of material. The rate of weight loss is linear over the period examined and can vary between over 5% per month to less than 1%, depending on the species.

The fastest weight losers are the spruces, which at present form the bulk of all timber which is being produced, with the most common species being Sitka spruce which loses weight faster than Norway spruce.

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