5 Evaluation of a ten year thinning experiment in Douglas fir

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Summary

In connection with the discussions on the necessity of thinnings in young Douglas fir (*Pseudotsuga menziesii*) stands in The Netherlands, the demonstration plot het Grevenhout (established 1947; initial spacing 1 x 1 m; low thinning, high thinning, no-thinning in two replications), the results of treatments applied and the quality and possibilities of the not-thinned plot were analysed.

Differences in h_{100} values in the plot indicated possible differences in site quality and differences in stem wood volume removed indicated variations in thinning intensities. The low thinning applied proved to be a low thinning indeed. In the not-thinned plots, enough dominant and co-dominant trees with long crowns and good growth potential remained after 40 year of no-thinning to select the 100-150 final crops trees as advised in forest practice. However, the h/d ratio, a measure of the stability of the tree, is high, indicating problems when final crop trees are released too quickly.

5.1 Introduction

In The Netherlands governmental plans exist to expand the area of Douglas fir plantations from 16000 ha to 54000 ha in the next decades (Anon., 1984). It seems likely that a considerable area of these future Douglas fir stands will be located on relatively poor sites, formerly occupied by first generation Scots pine. Under those circumstances an important management objective is to seek ways to minimize costs for thinning and other silvicultural practices.

The following considerations formed the basis for the present study:

1. In order to obtain a sustained yield it is questionable whether in all situations thinning is necessary in Douglas fir silviculture in western Europe.
2. From the viewpoint of stand stability there does not seem to be an absolute 'must' for thinning either. On the contrary: there is growing evidence that non-thinned stands are very stable (Savill, 1983).
3. No-thinning systems have the advantage that on the most valuable lower part of the stem the branches remain thin and that the annual rings will be relatively narrow and regular. If for good wood quality pruning is required, even in a non-thinned stand a limited number of crop trees can be selected to be pruned.

Unfortunately very few experiments exist to analyse the consequences of a no-thinning regime versus various thinning regimes that are or have been common praxis in Douglas fir silviculture.

In 1975 a thinning demonstration plot was established in a 28 year old, previously unthinned Douglas fir stand (1x1 m initial spacing), in 'het Grevenhout, vak 93 m', near Apeldoorn (Fig. 5.1). Three different treatments were applied with two replications each: two high thinning plots, in which only (dominant

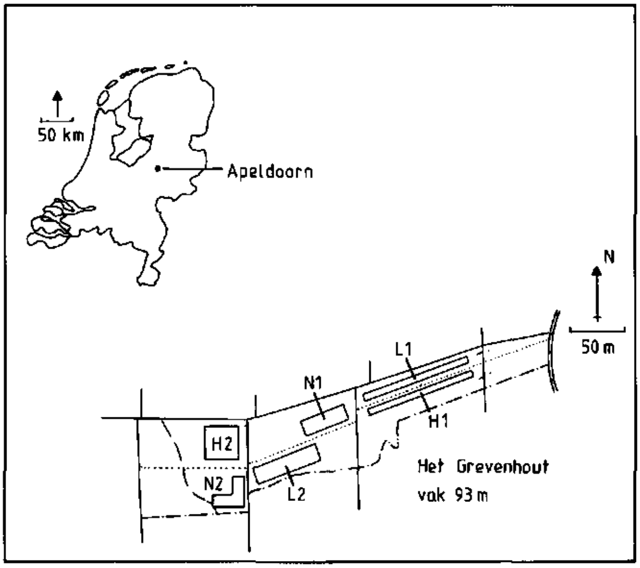

Fig. 5.1. Location of the sample plots in 'Het Grevenhout, vak 93 m'.

and codominant) trees from the higher strata were removed if they were competing with potential crop trees; two low thinning plots, in which only (intermediate and suppressed) trees were thinned from below; and two no-thinning plots. As far as we know the Grevenhout demonstration plot is the only experiment in The Netherlands in which different thinning methods in Douglas fir are compared. There exist other Douglas fir thinning plots (Tol, 1986), but these were established to study different thinning intensities of one particular high thinning method, which includes the selection of final crop trees.

5.2 Objectives

The main objectives of this study were:

1. to evaluate the Grevenhout experiment on its reliability and on the comparability of the three different treatments, given the fact that it was a demonstration plot rather than a carefully designed experimental plot;
2. to evaluate the development of the non-thinned plots so far, and to analyse the opportunities and consequences of more extensified silvicultural systems for Douglas fir.

5.3 Methods

To realize both objectives a number of hypotheses have been formulated and tested:

1. between the six plots there are no differences in site quality, as indicated by h_{100};
2. the different thinning methods have been applied correctly over the past ten years;
3. the thinning intensities have been about the same for the high thinnings as for the low thinnings, i.e. the amount of stem volume removed by thinnings was approximately the same;
4. the number of dominant and codominant trees in the non-thinned plots is such that sufficient potential crop trees can be selected;
5. the quality and growth potential of potential crop trees in the non- thinned plots, as indicated by d.b.h., h/d-ratio, crown length, crown width and basal area increment is more or less similar to that of potential crop trees in the other treatments.

In the early spring of 1985 six sample plots were established within the demonstration plots (Fig. 5.1). In each sample plot trees were tagged and mapped on a stem map. Of all trees in a 5 m wide belt transect, d.b.h., height, crown base and crown radius in four directions were measured, and an increment core from the south side of each tree was taken. With these data the mean height of 100 largest trees regularly spaced over a hectare (h_{100}) was calculated. Vertical diagrams were constructed, including a map of the vertical crown projection area, to analyse differences in stand structure and within stand competition between the plots. On the diagrams all trees were classified according to social position. These diagrams provide an excellent means to check such a classification in a verifiable way (Kuiper & Dijk, 1987). Data of the situation before the demonstration plots were established, were compared with data of the remaining stands and the number and amount of trees removed by the thinnings in 1976, 1980 and 1985. Various distributions were analysed, including those for dbh, h/d-ratio, relative crown length and the number of stems over the social classes.

5.4 Results

Table 5.1 gives the results of inventories in 1975, 1980 and 1985. The stands were analysed in 1975 and in 1980 by means of small circular sample plots (0.01-0.02 ha), which make these inventory data not very representative for the stands as a whole. The inventory in 1985, by which 10-20% of the area was sampled in each thinning plot (Table 5.2), is more representative. The data on the number of stems and total volume removed by the thinnings are accurate and reliable. This is the reason that e.g. the number of trees in 1985 added to the total number of trees removed by the thinnings in 1980 and 1976 is not the same as indicated by the 1975 data. The discrepancy is the result of different

Table 5.1. Stand data of the Grevenhout experiment in 1975, 1980 and 1985 before thinning, and thinnings in 1976, 1980 and 1985, all converted to 1 ha-values (Schoenmakers, 1987)

	1975 stand		1980 stand		1985 stand			1976 removed		1980 removed		1985 removed	
*	N	V	N	V	N	V	h_{100}	N	V	N	V	N	V
H1	2905	202	1500	208	1600	282	20.9	802	76	150	11	340	48
H2	1980	192	865	190	1000	222	21.3	355	52	45	6	211	46
L1	3030	139	2100	204	1400	323	19.2	1649	44	650	37	400	37
L2	3190	186	1190	233	1260	351	21.8	1911	59	350	37	167	24
N1	3280	178	2190	247	1360	255	22.3						
N2	2560	200	1500	267	1475	312	21.6						

* N = number of living trees/ha; V = total volume in m^3/ha; h_{100} = the mean height (m) of the 100 largest trees/ha, regularly spaced over the area. H1 and H2 are high thinning plots; L1 and L2 are low thinning plots; N1 and N2 are no-thinning plots.

Table 5.2. plot size and sample plot size of the 1985 inventory.

plot	size (ha)	sample plot size (ha)
H1	0.47	0.05
H2	0.44	0.09
L1	0.19	0.05
L2	0.31	0.09
N1	0.33	0.06
N2	0.41	0.06

inventory methods.

From Table 5.1 can be derived that the h_{100} values of e.g. plot H1, L1 and N1 are different. The differences correspond with more than one site class, according to the classification of La Bastide & Faber (1971). This would mean that hypothesis 1 is rejected. However, Dik (1987) could not find any significant differences in site quality between the plots. Some uncertainty remains about this point.

In Table 5.1 can also be seen that the thinning intensities, as indicated by the total volume removed, have been different for the high thinning plots compared with the low thinning plots. Thus hypothesis 3 is rejected.

Regarding an evaluation of a correct and consistent application of high and low thinning methods, the ratio of Delveaux (1968) is used, which classifies a thinning by comparison of the mean volume of the thinned trees with the mean volume of all trees before thinning. Values of this ratio smaller than 0.6 indicate an extreme low thinning; values larger than 1.2 indicate an extreme high thin-

Table 5.3. Values of the Delveaux-ratio for the thinnings in 1976, 1980 and 1985 (Schoenmakers, 1987).

	1976	1980	1985
H1	1.58	0.52	0.80
H2	1.69	0.56	0.98
L1	0.39	0.59	0.39
L2	0.31	0.53	0.52

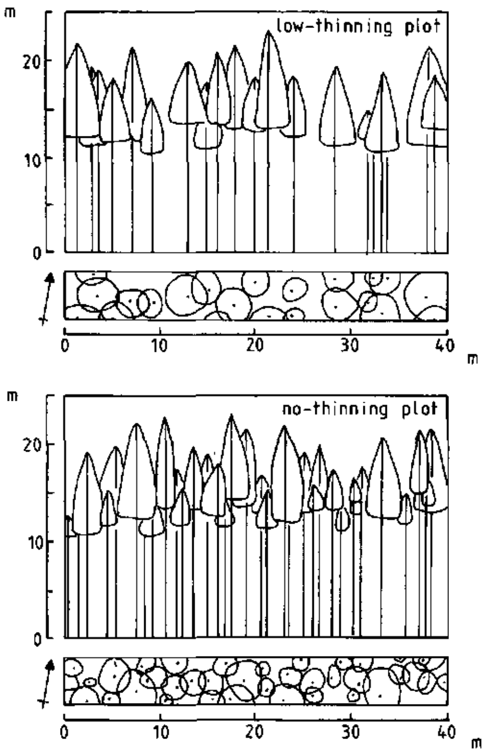

Fig. 5.2. Vertical diagrams of the structure of the low thinning plot L2 and of the no-thinning plot N1. In the non-thinned plot there are many intermediate and suppressed trees. In spite of the narrow spacing there seem to be as many well developed dominants as in the low thinning plot.

ning; values around 1.0 indicate a neutral thinning. Table 5.3 gives the results. In both low thinning plots the thinnings have been applied consistently. They are classified as extreme low thinnings, almost resembling self-thinning. The high thinnings on the other hand have not been applied correctly: in 1976 an extreme high thinning was carried out; in 1980 the thinning resembled more a low thinning, whereas the 1985 thinning should be classified as neutral. On the basis of these results hypothesis 2 is rejected.

Figure 5.2 gives an impression of the forest structure in the low thinned plot L2 and in the non-thinned plot N1, which lie close to each other and which are almost equal in site class. The non-thinned plot is much denser, with a lot of small, suppressed trees. Standing dead trees are not indicated on the diagrams, but in plot N1 over 3000 dead trees/ha were found (versus 1360 living trees).

Figure 5.3 gives the distribution of the number of stems over the social classes,

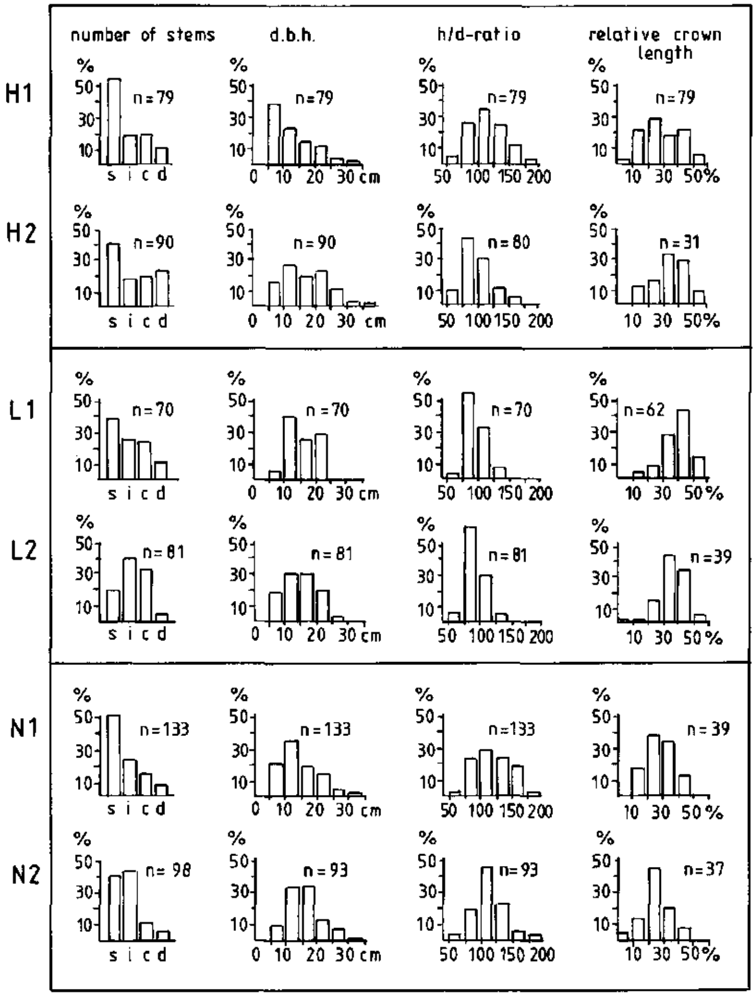

Fig. 5.3. Distributions of the number of stems over the social classes; of diameter at breast height; of h/d-ratio and of relative crown length for the six sample plots.

diameter distribution, distribution of h/d-ratio and of relative crown lengths for the 6 plots.

The total number of dominant and codominant trees/ha in the non-thinned plot N1 is 244 and 285 trees, respectively. In plot N2 there are 103 dominant and 211 codominant trees/ha, respectively. Schuetz & Tol (1982) advise to select no more than 100-150 Douglas fir crop trees per ha. This means that after 40 years of non-thinning there are still plenty of trees to make a selection of final crop trees from: hypothesis 4 approved. A complicating factor in the Grevenhout experiment is, that too many crop trees have been assigned at the beginning of the experiment: about 380 crop trees/ha. This is one of the reasons that the thinnings have not always been carried out correctly. Many crop trees have been spared that would otherwise have been thinned out if the thinning was applied irrespective of the presence of (too many) crop trees.

The number of dominant and codominant trees over 20 cm in diameter in the non-thinned plots is not much different from that in the other plots: on the average there are 350 trees/ha over 20 cm in diameter in the non-thinned plots; 375 trees/ha in the low thinning plots and 390 trees/ha in the high thinning plots. Both in the high thinning plots and in the no-thinning plots there are a few trees over 30 cm in diameter. In the low thinned plots such large trees are absent.

In the non-thinned plots only 43 trees/ha have an h/d-ratio smaller than 75. In the low thinning plots there are 79 such trees/ha and in the high thinning plots on the average there are 100 trees/ha with an h/d-ratio smaller than 75. Mind the risk of releasing crop trees! There are many trees with an h/d-ratio over 125 in both the high thinning plots and in the no-thinning plots.

Relative crown lengths longer than 35% of topheight amount to 130 trees/ha on the average in the non-thinned plots; 670 trees/ha in the low thinned plots and 460 trees/ha in the high thinned plots. Thus there are appreciable differences between the three treatments. The number of 130 trees/ha with relative crown lengths longer than 35% in the non-thinned plots, however, seems to be large enough to select candidates for crop trees.

Mean values of dbh, height, h/d-ratio, relative crown length and current annual basal area increment for dominant trees are given in Table 5.4. Analysis of variance indicated that there are no significant differences in these parameters between the plots.

To summarize, in the non-thinned plots there are sufficient large trees with relatively long crowns and a relatively good growth potential to provide a source for the selection of crop trees. Only the number of trees with an h/d-ratio lower than 75 is rather critical. Hypothesis 5 thus is (partly) approved.

5.5 Discussion

The Grevenhout demonstration plot has a number of serious disadvantages over a carefully designed experimental plot:

Table 5.4. Mean values with standard deviation (s) of various tree parameters for dominant trees in the six sample plots.

*	dbh	h	h/d	rcl	g_i	n
H1 mean	25.4	20.2	81	48	35.1	12
s	4.3	1.3	10	4	11.2	
H2 mean	24.7	19.8	81	47	29.9	8
s	2.6	1.1	7	7	14.8	
L1 mean	22.8	18.4	81	47	26.8	12
s	1.1	0.6	5	4	6.1	
L2 mean	25.8	21.3	83	44	29.6	12
s	2.7	1.1	10	5	9.1	
N1 mean	25.6	21.3	84	40	21.1	8
s	3.9	1.8	8	4	6.4	
N2 mean	23.8	21.3	91	36	19.4	10
s	4.0	1.5	12	6	5.8	

* dbh in cm; h in m; rcl = relative crown length in % of topheight; g_i = current annual basal area increment in cm^2; n = number of dominant trees sampled.

- the initial situation has not been documented thoroughly enough;
- there seem to be differences in site quality between the plots;
- the different thinning methods have not always been applied correctly;
- the thinning intensity has been different between the treatments;
- too many crop trees have been selected.

Thus it is concluded that this demonstration plot is not suitable for the purpose of studying the effect of different thinning methods on forest structure and on growth and yield (Schoenmakers, 1987; Dik, 1987).

On the other hand the non-thinned plots offer an unique opportunity for baseline studies. Especially the non-thinned plot N1 is very interesting, perhaps in combination with the low thinned plot L2. Therefore it is suggested not to continue the Grevenhout experiment in its present form, but to focus more specifically and in more detail on plots N1 and L2. The other plots than could be managed as a buffer zone. All trees in plots N1 and L2 should be tagged and mapped, so that reliable tree by tree data become available for future analyses.

An evaluation of the development of the non-thinned plots so far has made out some good cases in favour of more extensified silvicultural systems for Douglas fir on relatively poor sites. In spite of the narrow initial spacing of 1x1 m and consequently heavy competition, after 40 year of non-thinning apparently there are:

- sufficient trees with large diameters;
- sufficient trees with relatively long crowns;
- sufficient trees with a high basal area increment;

- many trees with a good wood quality and very thin branches, as judged subjectively;
- not sufficient trees with a low h/d-ratio.

Because the plots cannot be compared in a reliable way, no judgement can be made about total wood production. A thorough analysis of costs and yield can reveal whether or not under these site conditions the scale will deflect in favour of non-thinning. From a silvicultural point of view only the high h/d-values seem critical. The effect on all other parameters studied can be judged as positive. This suggests that silvicultural systems for Douglas fir based on less human interference deserve more attention in research and in forestry praxis.

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