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THE NUTRITION OF SITKA SPRUCE ON UPLAND RESTOCK SITES

by C.M.A. Taylor

Abstract

A recent series of Sitka spruce nutrition experiments established on a range of restock sites indicates that there is no need for application of fertiliser at the time of replanting, irrespective of site type. It is unlikely that subsequent fertiliser will be required on sites where there was a satisfactory crop yield in the first rotation without application of fertiliser. However, there are indications that topdressing may be required on the more infertile sites. This will be quantified in due course by monitoring growth responses to topdressing treatments planned for the experiment series.

Introduction

In the past, Forestry Commission nutrition research has concentrated on determining the requirements of plantations in the first rotation, following afforestation of nutrient-poor sites. However, in line with the increasing programme of restocking in the private and state sectors (now approximately 9000 ha per year in the uplands) a series of nutrition experiments has been recently established on second rotation Sitka spruce crops (see Figure 1). This series covers the major upland site types that have been previously identified as nutrient deficient (McIntosh, 1981) and is now yielding data on the benefits of fertiliser addition at time of replanting and, in due course, from topdressing applications.

Figure 1
Location of restock nutrition experiments.

Requirements at time of replanting

Early experimental results (see Table 1) allow comparisons between the height growth of trees without fertiliser (O) with those receiving phosphate (P), phosphate and potassium (PK) or nitrogen, phosphate and potassium (NPK) at time of planting. These data indicate good early growth across all treatments with no response to fertiliser (see Figure 2) over a range of site types, most of which would be regarded as nutrient deficient in the first rotation (see Photo 1). This improved status is due to nutrients becoming available from the decomposition of brash (needles, branches and tops) and the litter layer (Titus and Malcolm, 1987). It is not yet clear how long these benefits will last, particularly on the more infertile sites.

Concern has been expressed that more intensive harvesting systems might create nutrient deficiency problems. For example, removal of Sitka spruce brash might increase the harvested biomass yield by 20% but would increase removal of nitrogen by 240%, phosphate by 330% and potassium by 180% (Carey, 1980). This impact could be halved if removal from site was delayed until needles had fallen. Despite these rather alarming figures the total quantity of nutrient removed is relatively small compared with the remaining nutrient store on most sites. However, it could be a problem on our poorest sites, particularly where rotations may be shortened by other site factors.

Table 1 Experimental site details, treatments applied and age at which the latest mean height assessments were taken.

Experiment	Soil type	Lithology	Age*	Treatments
1. Coed-y-Brenin	Upland brown earth	Cambrian	9	O, P, PK
2. Ennerdale	Upland brown earth	Granite	6	O, P, NPK
3. Cynwyd	Intergrade	Ordovician	9	O, P, PK
4. Craigellachie	Ironpan	Dalradian	7	O, P
5. Speymouth	Ironpan	Old Red Sandstone	10	O, P
6. Wykeham	Ironpan	Calcareous Grit	4	O, P
7. Ae	Peaty gley	Silurian	3	O, PK
8. Falstone	Peaty gley	Carboniferous	3	O, P, NPK
9. Kilmichael	Peaty gley	Dalradian	3	O, P, PK
10. Margam	Peaty gley	Carboniferous	9	O, P, PK
11. North York Moors	Peaty gley	Estuarine	**	O, P
12. Glendaruel	Deep peat	Dalradian	5	O, P, PK
13. Inchnacardoch	Deep peat	Moine	5	O, P
14. Naver	Deep peat	Moine	6	O, PK
15. Falstone	Deep peat	Carboniferous	**	O, PK
16. Glentrool	Deep peat	Ordovician	**	O, PK

Notes

Treatment codes:

O = control, N = 150 kg N/ha as urea, P = 50-60 kg P/ha as rock phosphate, K = 100 kg K/ha as muriate of potash.

* Age of latest mean height values used in Figure 2. ** These experiments were recently planted.

Figure 2a Comparison of latest mean height values (m) between O and P treatments from experiments in Table 1.

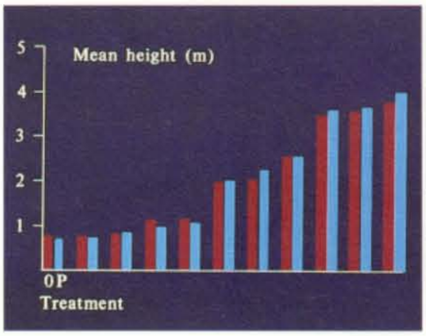
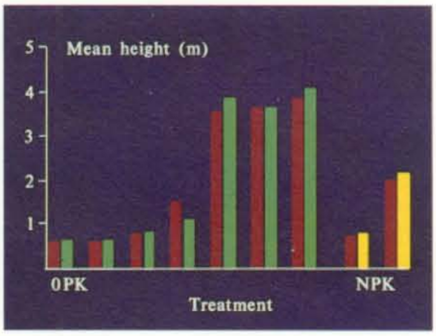


Figure 2b Comparison of latest mean height values (m) between O and PK, or O and NPK treatments from experiments in Table 1.



There are indications that brash offers some physical advantages (shelter) in the early establishment phase. In the experiment at Falstone on peaty gley, plots were stratified into brash zones and clear zones for growth measurement because visual differences were apparent (Table 2). The results indicate significant height differences between brash and clear zones although there were no significant differences in foliar nutrient concentrations, irrespective of fertiliser treatment. However, this difference in height is not large enough to give cause for concern over the strip patterns of brash caused by bench felling or mechanised harvesting (see front cover).

Table 2 Comparison of 3-year mean height growth (cm) between brash zones and clear zones across all treatments in the experiment at Falstone on peaty gley.

Treatment	Brash zone		Clear zone
O	87.0		77.0
P	83.9		82.4
NPK	87.6		82.1
Mean	86.2		80.5
5% l.s.d.		4.4	

Notes

O = control, P = 50 kg P/ha as rock phosphate in year 1.
NPK = 150 kg N/ha as urea, 50-60 kg P/ha as rock phosphate and 100 kg K/ha as muriate of potash in year 1.

Topdressing

On fertile sites which did not require fertiliser to achieve acceptable growth in the first rotation it is unlikely that restock crops will either require, or benefit from, fertiliser application. It is too early for the experiments to indicate what will happen on the more infertile sites and field evidence is limited because clear felling on such sites has only recently commenced on any scale.

One exception occurs on non-peaty heathland sites (particularly those overlying quartzite or siliceous sandstone) where pure Sitka crops are suffering from nitrogen deficiency, following previous crops of pure pine or larch. Results from the experiment at Speymouth (Table 3) indicate that there has been no response to phosphate fertiliser, but there has been a response to heather control and an additional large response to nitrogen. This is reflected in the foliar N levels, although the average levels are still low in the plots that have received nitrogen (deficiency threshold is 1.2% odw). Pure crops of Sitka spruce on these sites will require several applications of nitrogen to achieve full canopy closure, otherwise they will decline into check (see Photo 2). It is recommended that such sites are planted with pure pine or larch, or a mixture of Sitka spruce and Scots pine (Taylor, 1985).

Another possible exception has been identified by foliage analysis of pure Sitka spruce crops on estuarine peaty gley in the North York Moors, which become phosphate deficient within 5 years of planting. Fertiliser requirement will be quantified by the experiment allocated to that site type (Table 1).

Table 3 Mean height growth (m) at year 10 and average foliar N levels (per cent oven dry weight) for the period from years 3 to 10 in the Speymouth experiment.

Treatment	Mean height	Average foliar N levels
O	2.00	0.93
H	2.62	1.04
PH	2.60	1.00
NPH	3.80	1.18
5% l.s.d.	0.44	

Notes

O = control, H = heather control by herbicide in years 6 and 7.
PH = same treatment as H plus 50 kg P/ha as rock phosphate in year 1.
NPH = same treatment as PH plus 150 kg N/ha as urea in year 8.

1 *right* 8-year-old second rotation Sitka spruce crop on a deep peat site (Moine) growing satisfactorily without fertiliser. (*N. Mackell*)

2 *far right* 15-year-old second rotation pure Sitka spruce at Speymouth. Phosphate was applied in year 1 and heather was controlled in years 6 and 7. Growth check is developing because of nitrogen deficiency. (*C. Quine*)

FC/MLURI and FC/ITE projects

In addition to the series of key experiments, an intensive study area has just been established at Kielder in collaboration with the Macaulay Land Use Research Institute (MLURI). This study aims to monitor nutrient cycling in an age series of Sitka spruce stands, from pre-clearfell through to the thicket stage in the second rotation (Photo 3). It will also quantify the physical and chemical effects of harvesting residues on the growth of the restock crop, comparing plots that have been whole-tree harvested with conventionally harvested plots. These data can then be used to model the changes that occur during clearfell and establishment of the next crop, the impact of different harvesting techniques and the likely effect on site quality over several rotations.

There have been joint investigations with the Institute of Terrestrial Ecology (ITE) at Kershope and Beddgelert, concentrating on the effects of clear felling on nutrient release and the effects on water chemistry. This has indicated that there is unlikely to be any significant effects on downstream water quality (Stevens *et al.*, 1988).

Conclusions

Sitka spruce does not require, or benefit from, application of fertiliser at time of restocking, deriving adequate nutrients from the breakdown of the litter layer and brash. Later topdressing is unlikely to be required on sites that did not require fertiliser in the first rotation, but there are some indications that it may be required on sites low in available nitrogen or phosphate. While it is too early to quantify the requirements on most of these sites, it is clear that pure Sitka spruce crops will become nitrogen-deficient on poor heathland sites where, if used, it should be planted in mixture with Scots pine.

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3. The five crop stages being examined in the joint FC/MLURI project at Kielder. (*M. Proe*)

Pre-clearfell ▶

Pre-planting ▼

Post-planting ▲

Early thicket ▲

Late thicket ▶

Front Cover: Aerial view of clear felled sites in Glentrool (C. Quine).

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