The Effects of Fertiliser Treatments on the Growth and Composition of Sitka spruce

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This paper presents the results of some experimental work carried out jointly by members of the Chemical Research and the Forestry Divisions of the Ministry of Agriculture, Northern Ireland, with the Botany Department of the Queen's University, Belfast. Full details of the work will be found elsewhere. (McConaghy, *et al* 1962, and in preparation).

Summary

THE problem of check has caused concern for some ten years and the Forestry Division of the Ministry of Agriculture, Northern Ireland, first began investigating the matter in 1953. The results described in this paper relate to experiments which began in 1956.

A practical but expensive method of bringing trees out of check has been in operation for some time and has consisted of deepening drains and placing excavated peat round checked plants. Within four years of such treatment the average height of trees is more than double that of trees on untreated areas and annual growth rate is very significantly increased.

The effectiveness of such treatments is undoubtedly due to a combination of several factors, including better drainage, suppression of heather competition by peat litter and extra nutrients supplied by excavated peat.

Checked trees are always stunted and invariably show pale yellow colours, usually indicative of low needle nitrogen contents.

A pilot experiment laid down in 1956 included the use of various forms of nitrogenous materials, with and without phosphate; other nutrients included calcium as lime and gypsum, potassium, iron and copper. The best results were obtained with bone meal though later applications of hoof and horn meals also gave promising results in the year of application.

In 1957 two experiments were laid down when Sitka spruce seedlings were being transplanted in the peat. A further experiment, started in 1959 involved the aerial application of a compound fertiliser to established trees.

I. *Effects of placement of nitrogen and phosphate.*

In the first of the 1957 experiments a variety of nitrogenous materials was applied with a standard amount of basic slag. In two of the four blocks of treatments the fertilisers including basic slag were placed in and around the planting holes, and in the other two blocks

the fertilisers including basic slag were broadcast under the turf ribbons. The results have shown that with the exception of rich garden soil the nitrogen containing materials had little positive effect when placed in and around the planting holes, but bone meal containing both nitrogen and phosphate had a significant positive effect, and many other organic nitrogenous materials had a slight positive effect when broadcast under the turf ribbon. Treatments were much more effective when broadcast under the turf ribbon—apart from urea and ammonium nitrate which significantly depressed tree growth. Comparisons of the results by the two methods of fertiliser application are given in Table I.

Table I.

Mean tree heights and mean leader lengths (1960), four years after treatment.

Fertiliser position	Mean tree height (ins.)	Mean leader length (ins.)
Placed in and around planting hole	21.3	3.8
Broadcast under ribbon	24.4	5.5
Mean difference	3.1**	1.7**

** Differences significant at 1% level.

Analysis of tree needles in 1960 showed that both nitrogen and phosphate contents tended to be low and that all growth improvements were associated with increases in nitrogen contents and to some extent in phosphate contents of needles.

The effects of bone meal at different rates are summarised in Table II.

Table II.

	Response to bone meal			
	Fertiliser in and around hole		Fertiliser broadcast under ribbon	
Rate of application oz./tree	% N. in D.M.	% P. in D.M.	% N. in D.M.	% P. in D.M.
1	0.68	0.11	0.85	0.10
2	0.70	0.11	0.83	0.09
3	0.93	0.12	1.03	0.16

II. *The effects of lime and of different phosphates.*

This experiment consisted of 48 rows each of 50 trees in two blocks, one of which was limed with 50 cwt. ground limestone/acre before planting in Spring 1957. Phosphates were applied (with and without added nitrogen) as basic slag at 1 and 2 oz. per tree and as superphosphate, ground rock phosphate and bone meal, supplying phosphate equivalent to 2 oz. basic slag per tree. Tree measurements and needle samples were taken in April, 1961.

Results.

In the absence of phosphate trees made practically no growth and nitrogen alone had a deleterious effect. Lime in the absence of phosphate resulted in better tree growth by 1961, though lime had its usual effect of decreasing the availability of ground rock phosphate even under the very acid conditions of this site where the pH of the limed soil is still below 4.5. Trees on the limed block have improved with time and by 1960 were greener and healthier in appearance than on the no lime block. The main effects of treatments are summarised in Tables III and IV.

Table III.

Effect of applied N and of lime on tree growth and leader length

Treatment 1957	Mean tree height (1960) ins.		Mean leader length (1960) ins.	
	No Lime	Lime	No Lime	Lime
Nil	14.2	16.7	1.5	3.2
N only	11.4**	17.4	0.9	3.9
P only	22.9**	22.4**	4.5**	4.7*
N + P	23.0*	20.3**	5.0**	4.6*
G.R.P. only	23.3**	20.9**	5.3**	3.2
G.R.P. + N	22.4**	18.8	4.5**	3.5

* Significant at 5% level; ** Significant at 1% level.

Table IV.

Effects of treatments on nitrogen and phosphate contents of needles after three years : Sitka spruce

	Average percentage in dry matter of needles			
	Nitrogen (as N)		Phosphate (as P)	
Treatments	No Lime	Limed	No Lime	Limed
No phosphate	1.22	1.33	0.07	0.09
Basic slag. Rate 1	0.87	1.24	0.09	0.09
Basic slag. Rate 2	0.70	1.02	0.13	0.11
Superphosphate	1.09	1.06	0.12	0.10
Ground rock phosphate	1.11	1.14	0.11	0.08
Bone meal	0.80	1.08	0.11	0.10
Average	0.98	1.14	0.11	0.10

Needle samples from trees which had received no phosphate had very low phosphate contents but fairly high nitrogen contents. Lime, in the absence of phosphate, slightly increased the phosphate contents of needles presumably through its effect on peat decomposition. It also increased the nitrogenous contents of needles of trees which had received phosphate, though it tended to reduce height growth over the first three years. Lime, as expected, also had a significant effect on the calcium contents of needles. Added nitrogen had no effect either on tree growth or on nitrogen contents of needles.

III. *Effects of manuring on the growth of established trees.*

In established forests the growth of trees may often be limited by

low nutrient supplies. In 1959 a compound fertilizer (containing 6% N, 10% P_2O_5 and 8% K_2O) was applied from the air to Sitka spruce trees on a mountain peat soil in County Londonderry. Two plantations of trees were selected—nine and nineteen years old—in each of which there were areas where growth was poor. Within two years of treatment there was a significant increase in growth rate of trees which had previously been making unsatisfactory progress. Mature trees, nineteen years old, making apparently normal growth, showed no increase in growth rate as a result of treatment but the nine years old trees apparently making normal growth, showed a significant increase in growth rate as a result of the fertiliser. Results are summarised in Table V.

The general conclusions from these experiments may be summarised as follows :—

(1) that added nitrogen has only small and transient effects on growth of Sitka spruce growing on deep peat, or it may be toxic in some seasons at high levels;

(2) that phosphate is the most important factor limiting growth in early years;

(3) higher levels of phosphate than are normally supplied may be worthwhile and the position of placement of phosphate, relative to young tree roots, must be carefully considered.

Table V.

Effects of manuring on growth of established trees (Sitka spruce)

Age of trees (years)	Growth	Av. growth (ins.) June 1959	Treatment : NPK compound June 1959	Av. increase in growth (ins.) June 1959-61
	Good	15.08	None	0.79
19		14.32	Treated	0.74
	Poor	5.36	None	1.10
		6.40	Treated	1.94**
	Good	7.73	None	1.35
		6.55	Treated	1.90*
	Poor	4.62	None	0.98
		4.33	Treated	1.48**

References.

McConaghy, S., McAllister, J. S. V., Parkin, K. F., and Parker, R. E., 1962. The growth of Sitka spruce on deep peat in Northern Ireland. (i) The effect of fertilizers and other treatments on the growth of young trees.
Res. Exp. Rec. Min. Agric., N.I., 10, Part 2. In the press.

——— *et al* (ii) The effects of fertilizers and other treatment on composition of needles.
Res. Exp. Rec. Min. Agric., N.I., 11, Part 1. In preparation.