

# The Nursing of Sitka Spruce

## 1. Japanese larch<sup>1</sup>

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THE establishment of plantations of mixed species has been traditional in forestry for many decades. The purpose of mixing has been variously given; to protect against frost, to improve growth, to prevent soil deterioration, and others, but I have seen no record of a rigorous field experiment to examine the effects.

Sitka spruce (*Picea sitchensis* (Bong) Carr.) is the desired species over much of the land being afforested in Ireland. Its growth has not always been successful, and it has frequently been planted in mixture with lodgepole pine (*Pinus contorta* Douglas ex Loudon).

In 1960 an experiment was begun to test the effects on Sitka spruce of nursing by lodgepole pine and Japanese larch (*Larix leptolepis* (Sieb. & Zucc.) Gordon).

### The Site

The experiment is located in Lackendarragh, in Avondhu Forest, Co. Cork, at an elevation of about 225m. The soil is a podzolised gley, derived from sandstone of the Old Red Sandstone formation, with a thin layer (less than 2 cm) of peat. It is probable that, as with most of the Old Red Sandstone-derived soils of this region, a layer of peat of perhaps 30 cm had been removed for fuel during the nineteenth century. Prior to afforestation the site had been used for rough grazing, and carried a vegetation dominated by *Molinia caerulea* Moench and *Calluna vulgaris* Hull. In preparation for planting the area was ploughed with a single mouldboard Cuthbertson plough, without a tine, with furrows at 1.5m. The trees were planted 1.5m apart on top of the upturned ribbon and each was given a spot application of 85g of ground rock phosphate supplying 55kg P per ha.

### The Experiment

Mixtures were formed in two ways: intimate, in which alternate plants in each row were of the two species; and by bands, where two rows of spruce alternated with two rows of the nurse species. In effect, since the plants were regularly spaced, the intimate mixture was also an alternate one-row mixture with the rows at an angle of 45° to the planting lines.

1. Part 2, on nursing by leguminous species, will be published later.

2. Forest and Wildlife Service, Research Branch, Sidmonton Place, Bray, Co. Wicklow.

There were five treatments:-

1. *Control.* Pure Sitka spruce
2. *Spruce/larch. Intimate.* Sitka spruce and Japanese larch in intimate mixture.
3. *Spruce/larch. Bands.* Sitka spruce and Japanese larch in alternate double rows.
4. *Spruce/pine. Intimate.* Sitka spruce and lodgepole pine in intimate mixture.
5. *Spruce/pine. Bands.* Sitka spruce and lodgepole pine in alternate double rows.

All treatments were replicated three times in randomised blocks.

The lodgepole pine used in this experiment had been raised from seed collected in the region of Lulu Island, British Columbia. It is therefore not as fast growing or as heavy-crowned as the variety now used in Ireland, originating from the Washington and Oregon coastal region.

Initial growth was satisfactory, but within a few years all the Sitka spruce trees had entered a state of uniform stagnation with little or no height increment occurring. In late 1967 all plots were treated with a broadcast fertiliser mixture which supplied 65 kg N, 55 kg P and 105 kg K per ha. this caused only a slight response in the spruce, mainly in the form of increased needle length in 1968, but by 1969 this had disappeared. At that time, however, it was observed that the spruce in mixture with larch was slightly better in appearance than the spruce pure or in mixture with pine, and since then this superiority has visibly increased.

## Results

Periodic assessments of mean height and height increment of the Sitka spruce are summarised in Table 1. There were no differences between treatments up to the 10th year (1969). In the following 6 year period, 1970-75, the height increment of the spruce mixed with larch was significantly greater than that either of the pure spruce or the spruce mixed with lodgepole pine. The pine did not significantly improve spruce growth compared with that in pure spruce plots until the assessment of mean height at 18 years, when a significant increase is associated with nursing by pine. This is still significantly, and substantially, less than the increase associated with nursing by larch. The Sitka spruce nursed by Japanese larch is now growing in height at a rate of about 35 cm, compared with 10 cm in the pure plots, and about 15 cm in the plots nursed by lodgepole pine.

## Discussion

The general growth check which occurred in the first decade of the

TABLE 1

Effect of Japanese larch and lodgepole pine nurses on growth of Sitka spruce.

Assessments of mean height of spruce at successive ages, and height increment at selected periods. Data in metres.

Treatment	Mean height at age				Height inc.	Leader growth inc.			
	3	10	16	18	1970-75	1975	1976	1977	
Control	.43	.69	.94	1.19	.25	.07	.12	.10	
Spruce/larch, intimate	.41	.93	2.23	2.95	1.30	.27	.37	.34	
Spruce/larch, bands	.39	.85	1.95	2.71	1.10	.24	.35	.35	
Spruce/pine, intimate	.47	.74	1.16	1.51	.42	.10	.13	.16	
Spruce/pine, bands	.47	.77	1.26	1.59	.48	.11	.15	.17	
S.E.	.028	.049	.147	.072	.112	.026	.045	.037	
L.S.D. 5%*	n.s.	n.s.	.48	.23	.37	.08	.15	.12	

\*Least significant difference at 5% significance level. (n.s.=not significant)

experiment can be ascribed to phosphorus deficiency resulting from the original spot application of phosphorus fertiliser. This became ineffective as the tree roots grew away from the treated spots. The consequent phosphorus deficiency was corrected by the broadcast application of 55 kg/ha in 1967. After this it was possible for any potential nursing effects to be expressed, or, to put it another way, the factor which was now limiting the growth in the pure spruce and the spruce/pine plots, was overcome in the spruce/larch plots.

From other experiments and observations on Old Red Sandstone soils, I believe this factor was nitrogen deficiency. Foliar analysis carried out in October 1976 (Table 2) show that the nitrogen content of the spruce had been significantly increased in the plots mixed with larch. There was also a significant increase in the intimate mixture

TABLE 2

Effects of Japanese larch and lodgepole pine nurses on foliar nutrient contents of Sitka spruce in October 1976 (age 17 years). Data in percent of dry matter.

Treatment	N	P	K
Control	1.11	.16	1.08
Spruce/larch, intimate	1.58	.21	1.24
Spruce/larch, bands	1.47	.19	1.16
Spruce/pine, intimate	1.42	.17	1.08
Spruce/pine, bands	1.21	.17	1.05
S.E.	.071	.009	.051
L.S.D. 5%	.23	.03	n.s.

with pine, but not in the band mixture, and there was a significant increase in foliar phosphorus only in the plots mixed with larch. The differences in foliar potassium levels were not statistically significant, although their trend in general is similar to that for nitrogen and phosphorus.

Exactly how this improvement in nitrogen nutrition was brought about by the presence of Japanese larch is not clear. One possibility is through the suppression of ground vegetation. Growth check of spruce, associated with impaired nitrogen nutrition, probably caused by inhibition of mycorrhizae by exudates from *Calluna* roots, (Handley, 1963) can be overcome, at least temporarily, by killing the *Calluna* (Dickson and Savill, 1974). However in this experiment the beneficial effects of the larch on the spruce were visible before any considerable degree of vegetation suppression had taken place. The



Fig. 1. Sitka spruce nursed by Japanese larch at age 18. Mean height of spruce 2.8m.

present condition (late 1977 visually estimated) is that less than 20% of the *Calluna* layer has been suppressed in the larch plots and less than 10% in the pine plots.

Another, and in my opinion more likely explanation, is the mobilisation and rapid turnover, most importantly of nitrogen, by the deciduous larch.

### Practical implications

The present appearance of the Sitka spruce/Japanese larch plots (Fig. 1) is that of a reasonably promising crop. Current leader growth of the dominant trees is about 65 cm. This contrasts with the condition of the pure Sitka spruce crop (Fig. 2) which shows no promise at present of forming an economic forest crop, and would probably require substantial applications of fertiliser nitrogen in order to produce harvestable material.

The use of lodgepole pine as a nurse seems to hold much less promise. While the foliar analysis indicate an increase in N due to intimate mixing with lodgepole pine, this has not so far been reflected in significantly increased height increment in the Sitka spruce, although a small increase in mean height at 18 years was detected. However, with a mean height of 1.6m, compared with 4.2m in the lodgepole pine, the spruce must at present be at a disadvantage in this relationship and liable to be eventually suppressed by its nurse. This



Fig. 2. Sitka spruce without a nurse at 18 years. Mean height 1.2m

is the case with the variety of lodgepole pine used in the experiment, which is of Lulu Island origin; with the more vigorous coastal variety of lodgepole pine now in general use the relationship would be even more unbalanced leading to earlier suppression of the spruce.

In using Japanese larch as a nurse for Sitka spruce there is scope for variation in the arrangement of the mixture. The results obtained, and the probable reasons for the effect, suggest that intimate mixture would be best, but this would be feasible only in circumstances where intensive management is possible. In practice an arrangement such as one line of Sitka spruce, alternating with two or three lines of Japanese larch, might be adopted. This would allow early line thinning, combined with an extended nursing period before all of the larch was removed in thinning. There is considerable scope for investigation of the economic consequences of the various options available.

In conclusion it appears that a Sitka spruce/Japanese larch mixture would be an acceptable alternative to a pure crop of lodgepole pine on mineral soils not suitable for pure Sitka spruce.

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The chemical analyses were carried out in the Soil Laboratory, Johnstown Castle, Wexford.

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### References

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## Letter to the Editor

Dear Sir,

For the sake of other Clare farmers, I must protest at the 1st Conclusion to "Land Drainage in County Clare", in your last issue, that: "Draining the wet land of the county can be done. The technology and techniques of doing it are there, and the proof of success is there in plenty". To make such claims after only two years trial is surely unscientific.