EFFECT OF PRECISION SOWING ON GROWTH OF *PINUS RADIATA* SEEDLINGS AT EDENDALE NURSERY

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ABSTRACT

Seed was precision sown at 4, 6, and 8 cm spacing in drills 15 cm apart and seedlings raised as 1/0 planting stock.

There was a marked difference in quality of seedlings from each spacing. Those seedlings raised at 4 cm spacing had a higher percentage of culls (31%) than those raised at 6 and 8 cm spacing (6 and 7%, respectively).

Growth response following planting-out indicated that those seedlings raised at 6 and 8 cm spacing grew more vigorously (as measured by root growth potential, stem height and diameter growth, bulk index, and oven dry weight) than those seedlings which had been raised at 4 cm spacing. Recommended in-drill spacing for seedlings to be planted on benign or well cultivated sites should be not less than 6 cm. Seedlings to be established on harsher inland sites may need to be raised at wider in-drill spacings but this needs further elucidation.

INTRODUCTION

Numerous trials over recent years have demonstrated the effect that seedling spacing within drills has on seedling quality and growth following planting out. Some of this work has recently been summarised (Bowles, 1981). It has become obvious that in-drill spacing of seedlings is critical and that optimum spacing is dependent on soil type and locality of the nursery. A spacing trial was established at Edendale Nursery to determine optimum spacing for raising 1/0 radiata pine planting stock.

Edendale Nursery was established in 1974, and has two major drawbacks of soil and climate. The silt and clay fraction of the soil is about 57%, far higher than the advisable maximum of 40%. Degradation of structure in such soils can lead to soil compaction, smearing, and crusting. However, so far, a gravel subsoil has given freedom from waterlogging and flooding. Provided that a rigid rotation of an improvement crop with tree

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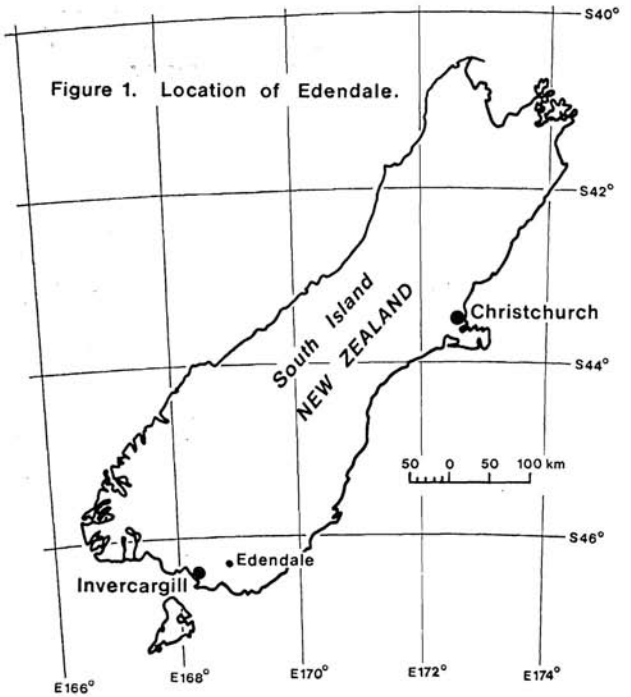

FIG. 1: *Location of Edendale.*

seedlings is practised, the site should be capable of producing good quality trees.

Edendale is south of the 46°S parallel (see Fig. 1) and is probably the most southerly major forest tree nursery in the world, and extremes of climate can be expected. The site is subject to very strong, cold, south-west winds with a considerable rainfall and sometimes sleet and hail from September to late November.

Seedbed preparation and sowing can be disrupted to the extent that delays from 4 to 6 weeks have occurred. Cold winds and hail have coincided with emergence of seedlings and new growth on stand-over crops. Further disruptions have occurred in the late summer-autumn season when wet weather has precluded any possibility of wrenching seedlings for periods up to 6 weeks.

Initially radiata pine seedlings were raised on the new site as 1½/0 planting stock to encourage innoculation of the site by mycorrhiza, and to ensure adequate size stock for planting,

but now 1/0 radiata pine stock is being grown. Sowing trials were conducted on the first crop of 1/0 radiata pine sown in 1976.

METHOD

Stratified *Pinus radiata* seed (CY/74/724) were hand sown at 4, 6, and 8 cm spacing in drills 15 cm apart in a 6 drill bed. A total of 1500 seeds were sown at each spacing in October 1976. A covering of light coloured washed 6 mm river gravel was used to cover the beds. All subsequent production methods were standard and are listed in Table 1.

TABLE 1: HISTORY OF TREE CROP
(Rates/hectare)

Pre-sowing fertiliser	22.5 kg of P in superphosphate.
Sowing date	5 October, 1976.
Spraying 20.10.76	Pre-emergent spray, consisting of 1 kg propazine and 220 g paraquat in 673 litres of water.
Spraying 2.11.76	Because of cold, wet conditions after sowing, there was no sign of radiata pine seedling emergence and a further pre-emergent spray was made. This spray consisted of 0.5 kg propazine and 220 g paraquat in 673 litres water.
Side dressing of fertiliser 25.1.77	17 kg P; 17 kg K and 16 kg N in Blue Label Mix No. 2 (Southland Phosphate Co.).
Undercutting 15.3.77	Undercut with reciprocating undercutter.
*Wrenching 24.3.77 and 29.3.77	Wrenched with straight bar wrencher.

*The lack of wrenching between 29.3.77 and 12.5.77 was because of most unfavourable climatic conditions. Because of the very wet soil conditions due to persistent heavy rain, machinery could not be used over the nursery beds.

Seedlings from the trial were lifted in mid-May 1977, culled and packaged into polythene bags with water and placed inside cartons for delivery to the planting site. Planting was conducted with mansfield spades using the wedge technique and growth was monitored for 12 months to determine growth responses.

RESULTS AND DISCUSSION

A survey of the beds prior to lifting indicated that final stocking of the beds was 86, 87, and 87% of the total numbers sown. Reasons for non-emergence of the remaining seed were not quantified.

Discussion is confined to the effect of precision sowing on quality and performance of radiata pine seedlings. The effect of seed spacing on grade output of seedlings will be the subject of a further paper.

Visual Culling

All seedlings were lifted and culled by nursery staff, who have had considerable experience, and Table 2 gives details of seedlings culled and reasons for culling.

TABLE 2: PERCENTAGE SEEDLINGS CULLED

In-drill Spacing	*Reasons for Culling*				*Total Cull (%)*
	Poor Root Development	*Spindly Shoot*	*Stunted Top Growth*	*Multi-leadered*	
4	11.1	10.7	6.3	2.8	30.9
6	3.3	0.3	1.5	1.4	6.5
8	0.5	0.1	4.5	2.4	7.5

It can be seen that there was a marked reduction in numbers of seedlings culled as in-drill spacing increased from 4 to 6 cm, (sgnificant at the 1% level, chi-square test).

Taking into account that total stocking at lifting was 86%, then only 56% of the seed sown at 4 cm spacing produced plantable trees, while around 80% of the seed sown at 6 and 8 cm spacing produced plantable seedlings as a direct result of the reduced need to cull. This means that, while 150 seeds were sown per metre of bed at 4 cm spacing (assuming 6 drills per bed), then 84 were plantable. At 6 and 8 cm spacing, 80 and 60 seedlings per metre of bed were plantable.

Effect of Spacing on Root Growth Potential

A total of 180 plantable seedlings from each spacing treatment were potted up in river-washed sand and placed in a glasshouse. Temperature was maintained at 21°C during the day and 16°C at night. Pots were watered every second day using distilled water. After 28 days the seedlings were excavated and washed and numbers and length of fresh white rootlets were assessed. These data are summarised in Table 3.

There were significantly fewer new roots and significantly less total new root length per plant (1% level) at 4 cm spacing compared with 6 and 8 cm spacing.

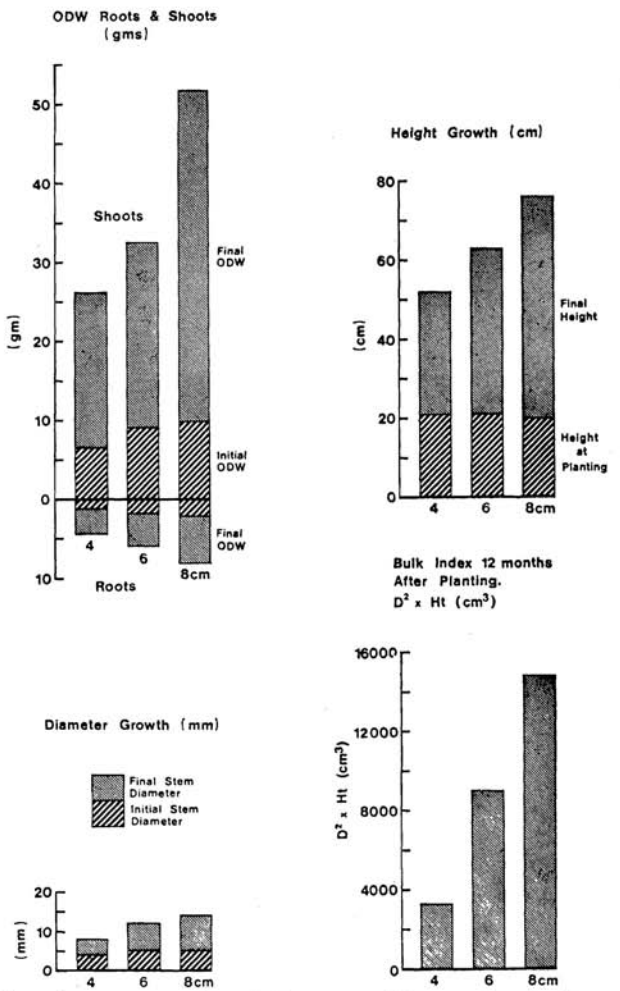

FIG. 2: *Growth parameters in relation to seedling spacing in the nursery.*

TABLE OF SIGNIFICANT DIFFERENCES (5%)

Treatments ranked best to worst; treatments linked by parentheses are not significantly different

Init. ODW	*Final ODW*	*Final Ht.*	*Ht. Incr.*	*Final Dia.*	*Dia. Incr.*	*Bulk Index*
8)	8	8	8	8)	8)	8
6)	6)	6	6	6)	6)	6
4	4)	4	4	4	4	4

TABLE 3: EFFECT OF IN-DRILL SPACING ON ROOT GROWTH POTENTIAL

Spacing (cm)	*New Root Growth*	
	Mean No./Plant	*Total Length/Plant (mm)*
4	8	17
6	13	36
8	14	36

Growth After Planting

A total of 250 good seedlings from each spacing were established on a benign site at Eyrewell Forest in Canterbury and the growth monitored for 12 months after planting. Also a sample of 250 seedlings/spacing were oven dried to determine the initial mean oven dry weight (ODW) of the roots and tops at the time of planting and all seedlings that were planted out were lifted after final growth assessment and mean ODW determined. A summary of these data is given in Fig. 2.

Survival exceeded 95% for all three spacings (not significant at 5% level).

Growth differences, as measured by ODW, height, stem diameter, and bulk index, indicated a marked difference between seedlings raised at the three spacings tested. These spacings are considerably greater than that necessary in other nurseries (Bowles, 1981). For example, the minimum acceptable spacing, for 1/0 radiata pine at the FRI nursery, to obtain high quality seedlings was 2.5 cm; for 1½/0 stock, the minimum spacing was 4.5 cm. An earlier trial at Milton Nursery (Otago) indicated that the optimum spacing for 1/0 radiata pine was found to be 7 cm and for 1½/0 radiata pine 9 cm spacing. These differences can be attributable to differences in location, climate, and soils and need to be taken into account when sowing programmes are planned.

CONCLUSIONS

At Edendale Nursery, with the drills spaced at 15 cm apart, increasing the spacing within the drills from 4 to 6 cm had the following effects:

1. A greatly reduced need to cull (from 30% culls to 6% culls).
2. A similar number of plantable seedlings per metre of bed (80 seedlings compared with 82 seedlings per metre of bed).

3. An increase in plantable seedlings from 55 per 100 seeds sown to 80 per 100 seed sown.
4. A greatly increased root growth potential of seedlings after planting out.
5. Greatly increased growth of seedlings once planted out in the field.

Increasing the spacing within the seed drills from 6 to 8 cm gave further significant increases in growth after planting out, but resulted in a 25% loss of production of plantable seedlings per metre of bed.

On the basis of this trial it is recommended that, where planting sites are reasonably benign, an in-drill spacing of 6 cm should be the aim. This, however, may not be adequate when raising seedlings for harsher inland planting sites and further work is needed in this area.

ACKNOWLEDGEMENTS

The assistance of George Stockley (Officer-in-Charge, Edendale Nursery, now retired) and Rod Cameron (Science Technician) is gratefully acknowledged.

REFERENCE

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