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**NURSERY SPACING AND GRADING  
OF SLASH PINE SEEDLINGS**

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# NURSERY SPACING AND GRADING OF SLASH PINE SEEDLINGS

## SUMMARY

Two experiments with seedlings of Slash Pine are described. One, dealing with the spacing of seedlings in the nursery beds, suggests that a stocking of about 30 seedlings per square foot should be aimed at. Heavier stockings, which produce an increased number of plantable seedlings even though the percentage of such seedlings is reduced, should be tolerated unless the stocking exceeds 54 seedlings per square foot, when some thinning may be desirable.

Grading studies indicated that 1 + 0 seedlings of small size and lacking secondary needles and resting-buds, should be culled but that other 1 + 0 grades give satisfactory survival and growth. 2 + 0 stock however is unsuitable for planting.

## INTRODUCTION

Woolgoolga Nursery, on the North Coast of N.S.W., is the main source of seedlings for use in the State's plantations of Slash Pine (*Pinus elliottii* Engelm.). The nursery is situated about 3 miles from the coast at an altitude of about 50 ft., and has a subtropical climate. Annual rainfall averages 61 inches, with February and March the wettest months and August and September the driest. Occasional light frosts are experienced during the winter months.

Seed beds in the nursery measure 16 ft. wide by 120 ft. long, and are drill sown to contain 24 rows spaced 8 inches apart. Wakeley (1954) recommends the production of 30 seedlings of Slash Pine per square foot (*i.e.* 20 seedlings per foot of row at 8 inch spacing), and at Woolgoolga the aim in recent years has been to produce this stocking. Stratified seed is sown in August, and the seedlings are planted out as 1 + 0 stock the following May and June.

The seed-sowing machines used generally in N.S.W. forest nurseries are apt to give somewhat uneven sowing. Whilst the stocking of seeds (and subsequently of seedlings) can be regulated to give a desirable mean when taken over an entire bed, individual sections of the nursery rows may carry no seedlings or may carry considerably more than are regarded as desirable. In a check count of 4 months old seedlings at Woolgoolga in 1958, using 2-foot lengths of rows, the range of stockings given in Table I was encountered.

TABLE I  
*Range of Nursery Stockings*

No. seedlings/ft.	Percentage of samples
0-5	3
6-10	5
11-15	9
16-20	16
21-25	20
26-30	18
31-35	17
36-40	8
41-45	2
46-50	1
51-55	0
56-60	1

Such results are by no means atypical, and it has become established practice to thin out the more heavily stocked sections of the beds once or twice during the nursery season. This is usually done when the seedlings are from 4 to 5 months of age, and again when 6 to 7 months of age.

At the end of the nursery season the seedlings available for planting vary greatly in both size and state of development, ranging from fairly large, well developed seedlings with a winter resting-bud and numerous secondary needles to small, soft seedlings lacking both resting-bud and secondary needles.

In order to determine the suitability of these various classes of seedlings for planting an experiment was carried out at the nearby Barcoongere Plantation in 1957, using seedlings of known grade, whilst to determine the need and effectiveness of the nursery thinnings a small experiment was commenced at Woolgoolga in January, 1959.

#### GRADING EXPERIMENT

In the grading experiment four grades of 1 + 0 stock were recognised, and in addition three batches of 2 + 0 seedlings which had been carried over from the previous year without further treatment were also included in the trial. The seven grades thus recognised were :—

- A. 1 + 0 stock, 7-10 inches high, secondary needles predominating, resting-bud formed.
- B. 1 + 0 stock, 7-10 inches high, fewer secondary needles, no resting-bud.
- C. 1 + 0 stock, 3-6 inches high, secondary needles predominating, resting-bud formed.
- D. 1 + 0 stock, 3-6 inches high, few or no secondary needles, no resting-bud.
- E. 2 + 0 stock, 18-24 inches high.
- F. 2 + 0 stock, 12-18 inches high.
- G. 2 + 0 stock, 6-12 inches high.

All 2 + 0 stock had winter resting-buds and secondary needles.

Planting was carried out during the winter of 1957. Each batch was replicated four times, with five adjacent rows being planted to a batch at a time. The entire planting covered 35 acres.

In September, 1959 ( $2\frac{1}{2}$  years after planting) two plots were established in each replication, and the surviving plants were measured for height. The results of this assessment are given in Table II.

TABLE II

*Survival and Growth of Slash Pine Grades, 2½ years*

Grade	Initial Height (1957)	Average Stocking	Mean Height (1959)	Mean Increment	Loss
	ft.	acres	ft.	ft.	per cent.
A	0·7	520	3·3	2·6	6
B	0·7	505	3·1	2·4	9
C	0·4	505	2·7	2·3	9
D	0·4	427	2·6	2·2	23
E	1·7	449	3·8	2·1	19
F	1·3	468	3·5	2·2	16
G	0·7	472	2·6	1·9	15

## THINNING EXPERIMENT

For the thinning experiment a 4-foot section towards the centre of a bed sown in August, 1958, was selected. The bed had previously been treated in a routine fashion and no thinning of the seedlings had been carried out. The section was deliberately chosen to provide a somewhat higher stocking of seedlings than was average for the nursery as a whole.

The section covered the full width of the bed and contained 24 rows of seedlings. All seedlings in each row were counted: the counts for the 4-foot lengths ranged from 82 seedlings (20·5 per foot) to 175 (43·8 per foot); with a mean of 114 (28·5 per foot).

Six thinning treatments were to be given:—

Treatment	Seedlings/sq. ft.	=	Seedlings/ ft. of row	=	Seedlings/4 ft.
a	18		12		48
b	24		16		64
c	30		20		80
d	36		24		96
e	45		30		120
f	54		36		144

Each consecutive batch of six rows was taken as a treatment block, and the treatments were distributed to the rows within the block as randomly as possible, but making adjustments where necessary for the heavier stockings to go to the more heavily stocked rows. Despite this, in block 2 only 134 seedlings were available in the most heavily stocked row for treatment f. Block 4 was treated with the other three, but had later to be discarded.

Thinning was carried out in early January, 1959.

Seedlings in blocks 1, 2 and 3 were lifted in early May and each batch was divided into four grades, corresponding to Grades A to D for 1 + 0 stock in the earlier grading trial. The recovery of seedlings obtained is shown in Appendix I. Row (1) f was a boundary row and there seems little doubt that the more open conditions it experienced caused it to produce a larger number of higher grade seedlings than would otherwise be expected. For this reason it should be excluded from further consideration.

Small errors in the original count of seedlings in January caused the actual row stockings to vary slightly from what was theoretically desired. The mean stockings obtained (derived from three replications of treatments a to e, and two of treatment f) are shown in Table III.

TABLE III  
*Actual Stockings obtained in Thinning*

Treatment	..	..	a	b	c	d	e	f
Mean No./4 ft.	..	..	50.3	68.3	77.0	92.7	117.7	140.0
Mean No./ft.	..	..	12.6	17.1	19.3	23.2	29.4	35.0
Scheduled No./ft.	..	..	12	16	20	24	30	36

#### DISCUSSION

Considering the grading experiment first, as this bears on the results of the thinning experiment, it can be readily seen (Table II) that the 2 + 0 stock in all three grades affected (E, F, G) has shown a relatively heavy loss of 15 to 20 per cent., whilst its growth rate has generally been somewhat poorer than for 1 + 0 stock. Although no comparison was made in this experiment between 2 + 0 stock and 1 + 1 transplants, general experience with transplants suggests that they withstand planting out much better. For this reason it appears that when excess nursery stock remains at the end of a planting season and it is desired to carry it over for another year, the extra effort in lifting and transplanting the seedlings in the nursery is justified. This is being tested in a current experiment. On the other hand the keeping of seedlings as 2 + 0 stock can barely be justified and such stock should not be planted.

The batches of 1 + 0 stock (grades A, B, C, D) are of greater interest since these represent the planting material normally used with Slash Pine on the North Coast. Grade A, which represents the ideal seedling for planting by present standards, has given a better survival rate and a better rate of increment than the other grades, though the differences are not statistically significant from the survival and growth of grades B and C.

Grade D clearly represents the true culls and this grade should be neither planted nor kept as transplants. Grades B and C, however, differ so little from grade A that all three grades can be regarded as suitable for planting. This indeed is the case at present, except that in practice the smaller seedlings in grade C are usually culled out because seedlings under 4 or 5 inches in height are awkward to handle in the field and consequently increase planting costs.

Returning to the nursery thinning experiment, the general results from the grading experiment can now be applied. Of the four grades of seedlings recovered from each thinning treatment, grades A and B are definitely plantable, while grade D seedlings should be regarded as culls. For grade C, some are plantable and some are not, depending on actual size, and a division of the grade into half plantable and half culls would be close to the break-up normally achieved in practice.

Using this division the numbers of plantable seedlings in each row, shown in Appendix I, have been obtained. Referring these values to the total number of seedlings in each row, the percentage of plantable seedlings can be readily obtained. These results are summarised for each spacing in Table IV and shown graphically in Figure I.

TABLE IV  
*Recovery of Plantable Seedlings by Thinning*

Treatment .. ..	a	b	c	d	e	f
No. Seedlings/ft. ..	12.6	17.1	19.3	23.2	29.4	35.0
No. Plantable Seedlings/ft. ..	8.0	11.0	11.3	13.5	16.4	17.6
Percentage Plantable Seedlings .. ..	63	64	59	58	56	50

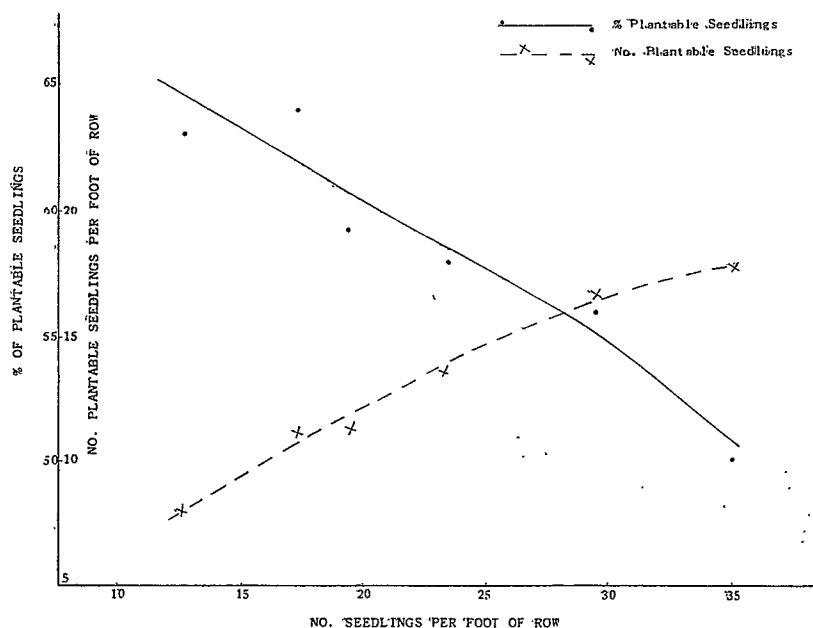


Fig. 1.

These show that a stocking of 35 seedlings per foot has reduced the percentage of plantable stock by less than 15 per cent. compared with a stocking of 12 seedlings per foot. In actual yield of seedlings, the closest spacing (f) produces twice as many plantable seedlings as the most open rows. However, the flattening of the curve for the actual number of plantable seedlings at the higher densities will be noted, and it must be doubted whether more than 20 plantable seedlings per foot could be recovered from more heavily stocked rows.

The indications from this are fairly clear. Primarily, the heavy thinning of dense rows achieves little actual advantage. Certainly dense rows are more prone to the spread of disease, but this is more likely to occur in the first three months after sowing than later on when thinning has normally occurred. The thinning of external rows, no matter how densely stocked, is of very little avail (see row (x) f, Appendix I), as these rows will in any case produce a high percentage of plantable seedlings due to their relatively open conditions.

In the external rows at 8 inches spacing, thinning does produce a higher percentage of plantable seedlings, and these tend to be of somewhat larger size. However the larger size is not necessarily an advantage, and the thinning reduces the absolute number of plantable seedlings produced. If ample seedlings are available for the planting area, this reduction is not of great importance, but when, as happens, there is an undersupply of suitable stock, the planting programme can only be fulfilled by using obvious and unsatisfactory cull plants because potentially plantable seedlings have previously been thinned out.

Until recently the production of 20 seedlings per foot of row at Woolgoolga had been considered excessively heavy, although this spacing is recommended by Wakeley (pp. 73-74). Whilst there is obviously a wide degree of latitude in the nursery spacing tolerated by Slash Pine seedlings, 20 seedlings per foot of row (30 per square foot) does indeed seem to offer a suitable compromise between the maximum recovery of plantable seedlings on both absolute and percentage basis : in other words, a compromise between obtaining the greatest number of plantable seedlings from a given quantity of seed on the one hand, and using not too great an area of nursery beds, with the consequent increased costs of preparation, sowing and maintenance, on the other.

From this it would seem that the sowing rate should aim to establish 20 seedlings per foot of row (8 inches between rows). Where the establishment is heavier than this thinning is unnecessary unless the stocking is above 36 seedlings per foot, when thinning to reduce the stocking to about 30 seedlings per foot is probably desirable.

## CONCLUSION

The first experiment described showed that small, 1 + 0 seedlings of Slash Pine, lacking both secondary needles and resting-buds, are unsuitable for planting and should be culled out. However small seedlings with resting-buds and some secondary needles, and larger seedlings with secondary needles and with or without resting-buds, can be regarded as plantable seedlings, though some in the smaller sizes may have to be culled due to the physical difficulty of planting very small seedlings. Obviously, diseased and badly damaged seedlings should also be culled, regardless of size, needle form and the presence of a resting-bud. These conclusions agree closely with the recommendations of Wakeley (p. 110) for the grading of Southern Pine nursery stock, and they should be applied in future in the Southern Pine nurseries of northern N.S.W.

2 + 0 seedlings also appear unsuitable for planting, and until further information is available Slash Pine seedlings carried over from one planting season to the next should be lifted and transplanted at the end of the first season for subsequent use as 1 + 1 stock.

The sowing rate in the nursery should aim to produce 30 seedlings per square foot (20 per foot of row at 8 inches between rows). Higher stockings will produce a reduced percentage of plantable seedlings, though the absolute number produced will be increased. Thinning in these more densely stocked sections is costly and time-consuming and is unnecessary through the range of stockings normally encountered, but it may be desirable when the stocking exceeds 36 seedlings per foot of row (54 per square foot).

#### ACKNOWLEDGEMENT

It is desired to express thanks to Mr. R. R. Richmond, formerly forester at Woolgoolga, for his considerable aid in organising and carrying out the grading trial discussed above.

#### REFERENCE

Wakeley, P.C. (1954). "Planting the Southern Pines". U.S.F.S., Agric. Monogr. No. 18.

APPENDIX I

*Grades of Stock recovered after Thinning*

Row No.	Grade A	Grade B	Grade C	Grade D	Total	Number Plantable	Percentage Plantable
(1) a ..	4	18	11	14	47	27½	58
b ..	13	16	23	15	67	40½	60
c ..	10	24	20	22	76	44	58
d ..	12	21	29	15	87	57½	66
e ..	21	24	34	40	119	62	52
f ..	40	18	66	15	139	91	65
(2) a ..	5	18	12	17	52	29	56
b ..	13	22	19	16	70	44½	64
c ..	12	21	26	17	76	26	60
d ..	10	23	31	32	96	48½	51
e ..	23	22	21	49	115	55½	48
f ..	20	35	30	45	130	70	54
(3) a ..	12	24	8	8	52	40	77
b ..	12	30	10	16	68	47	69
c ..	11	25	22	21	79	47	60
d ..	13	30	26	24	93	56	60
e ..	23	40	32	23	119	79	66
f ..	12	27	43	68	150	70½	47

*Note—*

- (1) Each count represents the number of seedlings obtained in a 4 ft. length of row.
- (2) Grades A, B and half of C were regarded as plantable.
- (3) Row (1) f was a boundary row adjoining a path, and therefore had more open conditions than other rows.





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