

SEEDBED DENSITY INFLUENCES PRODUCTION AND SURVIVAL OF LOBLOLLY AND SLASH PINE NURSERY STOCK

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Recent studies in Louisiana have shown that a nursery bed density of about 40 slash or loblolly pine seedlings per square foot is preferable to lower densities in terms of both plantable size and effective seedlings produced. (Effective seedlings are plantable seedlings that survive 1 year in the field.) If the criterion is larger seedlings or more grade-1 stock, lower bed densities may be desirable.

Densities of approximately 10, 20, 30, and 40 seedlings per square foot of nursery bed were compared in these studies. Seedlings for two studies were grown in a small experimental nursery and those for the third in two of the Louisiana Forestry Commission's nurseries. Weeding, watering, spraying, and fertilizing were according to usual nursery practices. Soils were not fumigated, but no evidence of nematodes or root rot was observed.

Desired stocking levels were obtained by oversowing the plots and thinning them after germination was complete. As a few extra seedlings were retained in thinning to allow for expected summer mortality, final densities did not agree precisely with those prescribed (table 1).

Densities were replicated in the nursery and in outplantings. Nursery plots varied in size from 3-1/2 to 10 linear feet of bed. Field plots were rows of 25 trees. In the course of the studies more than 16,000 seedlings were graded and more than 5,000 were planted.

Size of Planting Stock

The best seedlings, in terms of morphological quality, were produced at a density of 10. They had stouter stems but no more height than those from denser beds.'

Plantable slash pines from low- density beds averaged 7/ 32 to 10/32 inch in rootcollar diameter, while those from high-density beds averaged 4/32 to 6/32. The pattern was about the same for loblolly, though diameters were slightly smaller (table 1).

The proportion of total production in various morphological grades is a good measure of the effect of bed density on physical suitability of seedlings for planting. Seedlings of the highest morphological quality (grade 1) are 3/16 inch or larger in rootcollar diameter and 5 to 12 inches (loblolly) and 6 to 14 inches (slash) in height. Nearly all needles of grade-1 stock are fascicled, and bark usually covers the entire stem. Seedlings of the other plantable grade (grade 2) are at least 1/8 inch in rootcollar diameter and at least 4 inches (loblolly) or 5 inches (slash) tall. They must also have some secondary needles and bark on the lower stem.

In these studies, more than 90 percent of the seedlings raised at a density of 10 were plantable, and over 70 percent were grade 1. In contrast, every third or fourth seedling from the plots of highest density was too small to plant, and less than 50 percent of the total production was grade 1.

Yield of Plantable Seedlings

The number of plantable seedlings of both species increased with each increase in density. The nominal density of 10 produced an average of 11.4 plantable slash and 12.4 plantable loblolly seedlings per square foot (table 1). Increasing density to 20 per square foot yielded an additional 8.8 slash and 7.0 loblolly of plantable size. Further increases from 20 to 30 and from 30 to 40 seedlings per square foot produced 6.5 and 3.5 additional

TABLE 1.--How nursery bed density affected size, yield, and survival of loblolly and slash nursery stock

Slash Pine

Study and nursery	Actual bed densities per square foot	Production per square foot of--		Proportion plantable	Size of plantable stock		First-year survival
		Plantable seedlings	Effective seedlings		Rootcollar diameter	Height	
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Percent</i>	<i>Inches</i>	<i>Inches</i>	<i>Percent</i>
1.....	11.3	11.0	10.1	97	9/32	10	92
	21.9	20.4	16.9	93	7/32	9	83
	32.1	27.2	20.6	85	6/32	10	76
	41.9	29.2	22.2	70	6/32	10	76
2.....	13.8	13.3	5.7	97	7/32	10	43
	23.2	20.6	7.8	89	6/32	11	38
	33.8	23.7	12.1	70	5/32	10	51
	44.9	29.7	9.8	66	4/32	10	33
3-A.....	10.8	10.0	9.8	94	10/32	7	98
	21.8	19.8	18.2	91	8/32	7	92
	31.6	27.8	25.2	88	6/32	7	90
	42.1	32.5	30.3	77	6/32	8	93
3-B.....	12.0	11.3	11.0	95	8/32	7	97
	22.1	20.0	19.0	90	7/32	7	95
	32.7	28.0	25.2	86	6/32	7	90
	38.1	29.3	28.2	77	6/32	8	96

Loblolly Pine

1.....	11.3	(¹)	(¹)	(¹)	7/32	10	91
	20.0	(¹)	(¹)	(¹)	6/32	10	86
	29.8	(¹)	(¹)	(¹)	6/32	9	82
	38.9	(¹)	(¹)	(¹)	5/32	8	82
2.....	14.4	13.6	12.1	94	7/32	10	89
	23.8	18.7	15.0	79	6/32	10	80
	37.9	24.0	18.5	63	5/32	8	77
	48.9	25.8	19.9	53	5/32	8	77
3-A.....	13.4	12.2	12.2	91	8/32	7	100
	21.6	19.7	19.7	91	6/32	7	100
	35.1	26.3	25.6	75	6/32	7	97
	43.8	29.8	28.6	68	5/32	7	96
3-B.....	11.8	11.5	11.5	97	8/32	11	100
	21.2	19.9	19.4	93	7/32	10	99
	30.9	26.8	26.5	87	6/32	11	99
	39.3	31.1	30.4	79	6/32	11	98

¹ No data.

plantable slash, respectively, and 6.3 and 3.2 additional plantable loblolly. A projection of this trend indicates that increases beyond 40 per square foot would bring little net gain in plantable seedlings.

Survival

Studies 1 and 2 were outplanted in moderately dry years. In the first planting, plantable seedlings from beds of lowest density survived best--92 percent of the slash and 91 percent of the loblolly were alive at the end of the first year. Field survival decreased as density was increased to 20 and 30 seedlings per square foot. Here densities of 30 and 40 gave equally good survival for both species. Similar trends were found in outplanting number 2 except that, for reasons unknown, survival of all slash pine was low, and seedlings grown at a density of 30 survived better than those at other densities.

Study 3 outplantings received adequate summer rain, and first-year survival was 90 percent or higher for both species at all densities.

The effect of weather on survival must be considered in interpreting these results. The data show that trees grown at low density withstood drought better than those grown at high density. They also indicate that, in more favorable years, high survival can be attained at any density in the range tested.

Effective Seedlings

Number of effective seedlings is a more rigorous measure of nursery bed density than either the yield of plantables or field survival. As has been mentioned, effective seedlings are plantables that survive their first year in the field. To illustrate, if one square foot of bed yields 30 plantable trees and 80 percent of them survive, the number of effectives is 24. Because summer droughts are frequent in the southern pine region, the following estimates are based on data from the research plantings in dry years--slash data are from study 1, and loblolly from study 2.

The number of effective seedlings produced at the 40 density was estimated to be 622,000 slash and 557,000 loblolly pines per acre of nursery. This was 45,000 more slash pines than were obtained from a density of 30; 148,000 more than from a density of 20; and 339,000 more than from a density of 10. Comparable values for loblolly pine were 39,000, 137,000, and 218,000 effective seedlings per acre. (These calculations assume that an acre of nursery contains 28,000 square feet of bed space.)

As with plantable seedlings, the gains diminished sharply with each increase in density. Between densities of 30 and 40, the gain averaged only 45,000 per acre for slash and 39,000 for loblolly. Consequently, densities much above 40 per square foot appear impractical.

Assuming that seedlings should be grown for outplanting in adverse years, was the density of 40 more efficient than 30? The only additional expenses associated with the extra effective seedlings from the denser beds were those for seed and for the labor of lifting and grading.

With average numbers of seeds per pound and a tree percent of 70, 28 pounds of slash seed and 22 of loblolly were required to increase bed density from 30 to 40. If slash seed costs \$3 per pound and loblolly \$4, the extra seed amounts to \$84 and \$88 per acre, respectively. Lifting and grading cost about \$0.50 per thousand for bed-run seedlings, and it was necessary to handle an additional 274,000 slash seedlings per acre and 308,000 loblolly to realize the increases in effectives. Thus, the extra effective seedlings cost about \$5.50 per thousand (\$6.20 for loblolly and \$4.90 for slash). As each thousand effectives represented about 1,300 plantable seedlings, the investment per thousand plantables was about \$4.25. Densities of 40 per square foot therefore appear well justified, for few if any southern nurseries are producing plantable seedlings for less than \$4.25 per thousand.