RESIDUAL EFFECTS OF NURSERY PRACTICES ON THE FIELD PERFORMANCE OF LOBLOLLY PINE [1]

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One of the principal objectives of nursery soil management is the production of a high quality seedling that will grow when it is out planted. In this respect, it is similar to soil management with other crops. It is different, however, in that we are dealing with a long lived crop that will grow and mature in a place different from that in which it was started. In this summation of our experience with loblolly pine we would like to show how nursery practices can affect the growth of the tree.

SURVIVAL

General

The nurseryman is expected to produce planting stock which will perform well under a wide variety of conditions--both preplanting and afterward. The vagaries of these conditions often result in poor performance of the stock for which the nurseryman frequently "gets the blame." An aspect of performance usually given top priority in forest planting programs is survival. The usual planter reasons that trees must survive to grow while in reality they must grow to survive.

The field performance of planting stock in terms of survival is predominantly beyond the influence of reasonable nursery seedbed practices. The studies we have carried out over the past decade, both in the research nursery and in the production nurseries, supports this generality. We have selected a few examples to illustrate the point.

Fertility

The survival values in table 1, which are from a study done in the research nursery at State College, show no effect of seedbed nitrogen fertilization. They only show uniformly quite acceptable values, even in the case of seedlings produced without nitrogen from plots continuously cropped for 5 years. Similar effects were noted for P and K fertilization (table 2). It should be pointed out that the P and K levels in the soil were very high at the beginning of this experiment. Also, this is seedling material produced and handled under rather intensive care.

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Table 1.--The effect of seedbed fertilization on the initial field survival of loblolly pine planting stock

Years of cropping	Seedbed nitrogen (pounds/acre) 0	150	300	Mean
1	98	98	98	98
2	99	98	98	98
3	98	99	100	99
4	100	100	100	100
5	90	91	93	92
Mean	97	97	98	97

Table 2.--The mean effects of nursery P and K rates on the initial field survival of loblolly pine planting stock

Years of cropping	P_2O_5 (pounds/acre)		K_2O (pounds/acre)	
	0	300	0	300
1	97	98	98	98
2	99	98	99	98
3	84	99	99	99
4	100	100	100	100
5	92	91	91	92
Mean	94	97	96	97

size, they have little effect on survival (table 3). At the densities employed, increasing the density is one way of reducing the amount of nitrogen available for each plant and thus affecting the size (or grade) of the seedling.

Table 3.--Initial survival as influenced by seedbed fertility and density, means of 3 year's plantings (bed-run sample)

Seedbed $N-P_2O-K_2O$ (pounds/acre)	Density (seedlings/square foot) 15	30	45	60	Mean
75-50-75	98	99	98	98	98
150-100-150	95	96	97	98	96
300-200-300	94	96	94	94	94
Mean	96	97	96	97	96

Grades

The survival of seedling grades grown under differing nitrogen levels at production nurseries was determined in 1961 and 1962. In 1961, there was little difference in survival among grades except that grade 3 grown at the high N level *(fig.* 1) had the lowest survival, probably due to its very poor top-root ratio. The survival in 1962 was not nearly as good and there were differences among grades. The generally poor survival with this stock is attributed principally to cold weathe] which occurred during lifting and to freezing temperatures which occurred immediately after outplanting.

Nurseries

We have compared the survival of seedlings produced at different nurseries (fig. 2). In the 1961 production, uniformly good survival was obtained regardless of seedbed nitrogen levels or nurseries. In 1962, survival was not nearly as good and there were wide differences among nitrogen levels and nurseries; in one nursery (a) the lowest N level gave the best survival, in another (b) the best survival was obtained at the highest N level. These survival differences are thought

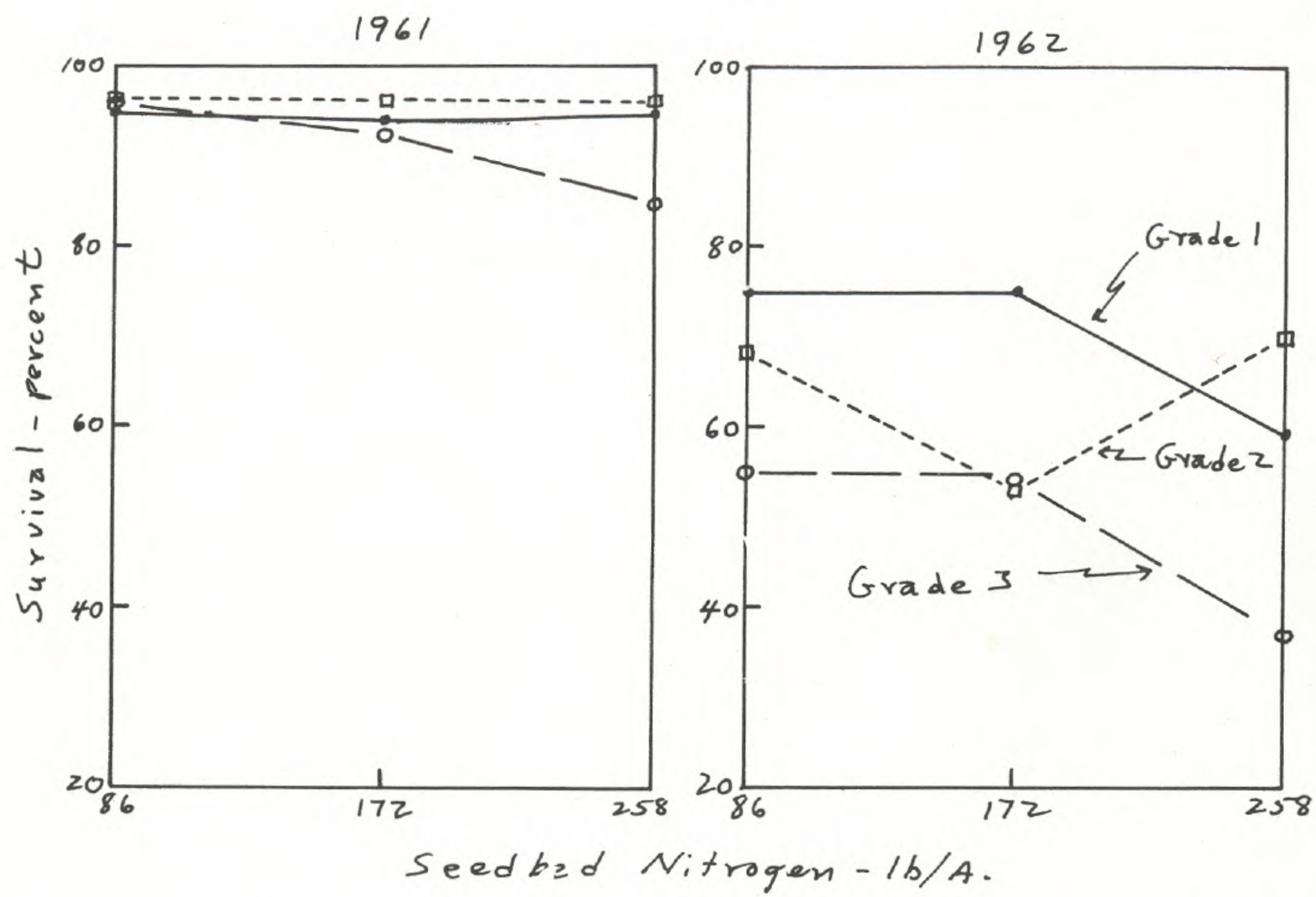

Figure 1.--The effect of seedbed fertilization on the initial survival of the three grades of loblolly pine seedlings in 1961 and 1962. Data are means of four nurseries.

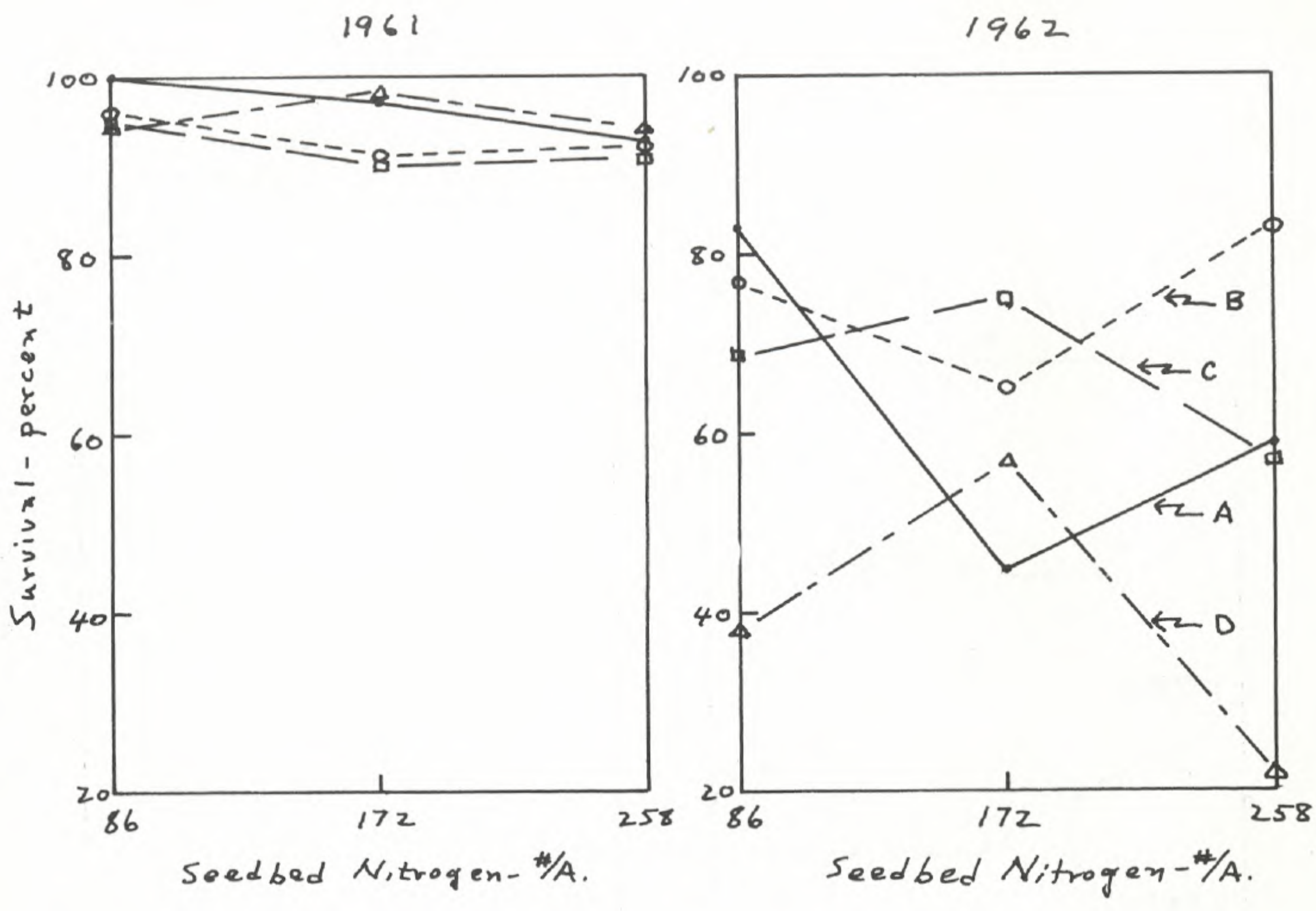

Figure 2.--The effect of seedbed nitrogen levels on the initial field survival of loblolly pine planting stock produced at four production nurseries. Data are means of grades 1, 2, and 3.

to be mainly a reflection of response to the freezing temperature prevailing during and immediately after planting. For example, the stock from the southernmost nursery had the lowest average survival and for this stock the lowest survival occurred at the highest N level.

Site

The marked effect of site on survival is shown in table 4. At the Experimental Forest site, a poorly drained silty clay loam alluvial soil, the mean first-year survival was 95 percent as compared to 69 percent on the Tombigbee site, an excessively drained loamy coarse sand alluvial soil' a difference of 26 percent. Third-year survival was 92 percent and 61 percent, respectively, for a difference of 31 percent. There were effects of seedbed fertility, as well. At the Experimental Forest site, first-year survival was decreased slightly by the high seedbed fertility level while on the Tombigbee site, first-year survival was increased slightly by seedbed fertility. At the latter site, however, third-year survival was considerably better at the highest seedbed fertility level. Figure 3 shows the pattern of survival on the Tombigbee site where it was found that survival increased with increasing depth to gravel. These results demonstrate that what happens to the seedling after it is planted out usually determines whether it will grow and survive.

Table 4.--The influence of seedbed fertility treatment and years from planting on survival of 1957 stock at two sites

$N-P_2O_5-K_2O$ (Pounds/acre)	Site: Experimental Forest	Site: Tombigbee
	Percent	Percent
FIRST-YEAR SURVIVAL		
75-50-75	99	64
150-100-150	94	72
300-200-300	91	70
Mean	95	69
THIRD-YEAR SURVIVAL		
75-50-75	96	57
150-100-150	92	56
300-200-300	89	70
Mean	92	61

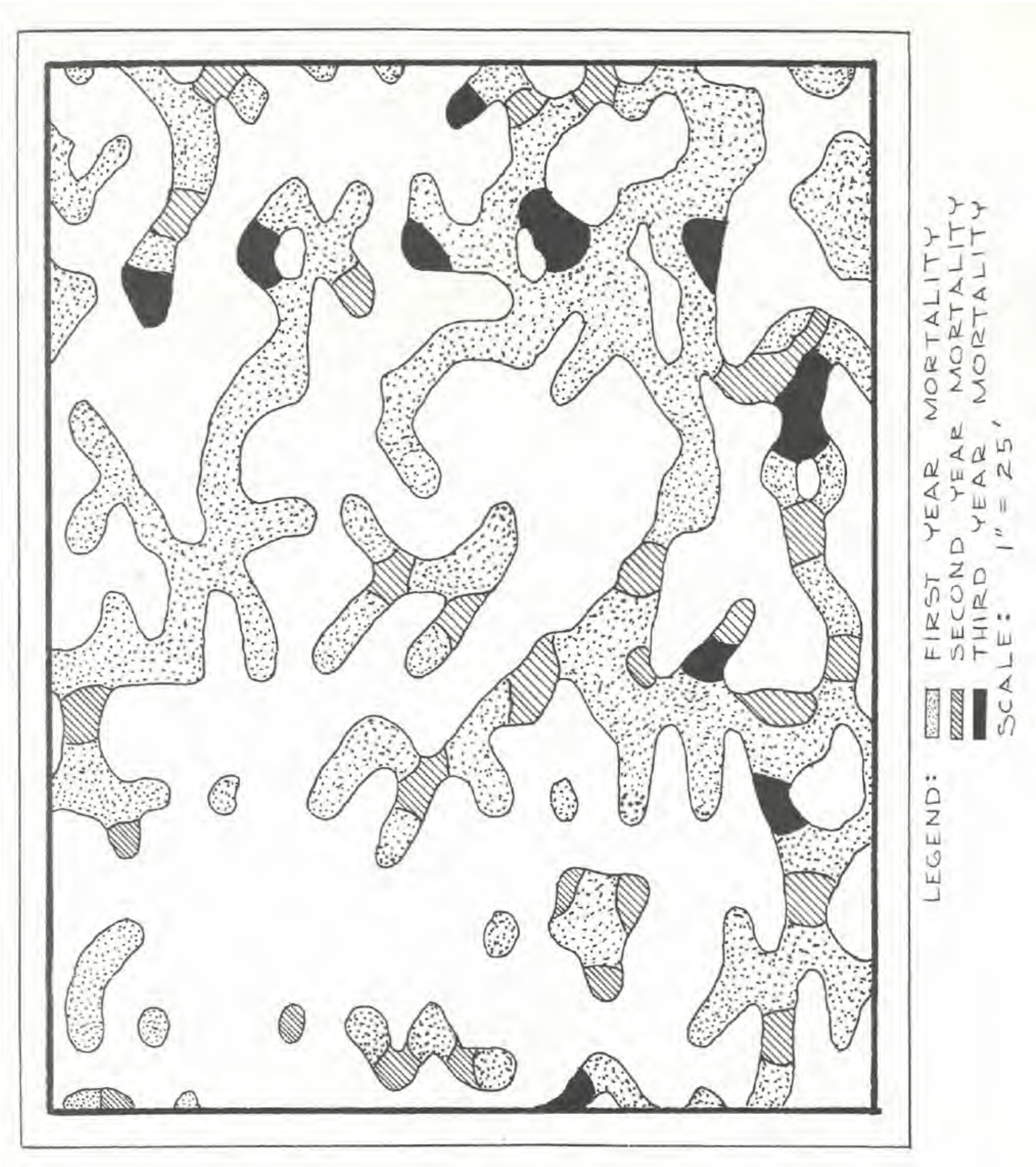

Figure 3.--The mortality pattern of loblolly pine seedlings (1957 stock) planted on Huckabee loamy coarse sand, gravelly substratum phase, Tombigbee.

GROWTH

General

The residual benefits beyond the seedbed can also be expressed in terms of height growth. In the following paragraphs we will illustrate how some of the seedbed practices affect height growth after planting.

Fertility

Our experience shows that the differences in seedling heights established in the seedbed by nitrogen applications (ca 20 percent) remains relatively the same through at least 5 years of growth although the actual differences become greater with increasing age *(fig.* 4).

Density and Fertility

The data in figure 5 indicate that field height growth increased with increasing fertility and decreasing density. These results can be explained by the fact that the general effects of treatment can be largely attributed to seedling size differences which were obtained during the period of seedbed occupancy.

Grades

If height growth is related to seedling size, then one would expect a difference in height growth among seedling grades. That this is true is shown in figure 6 where the means for four nurseries and three levels of nitrogen are plotted. Not shown, but also important, is the fact that the pattern of height growth for a seedling grade was essentially the same regardless of the nitrogen level in the seedbed in which it was produced.

Nurseries

There are differences in the height growth of seedlings produced at different nurseries *(fig. 7)* but these differences are more pronounced with some year's stock than with others. No doubt this is partly due to annual differences in size of the seedlings.

Site

Obviously, the site is going to affect the rate at which a seedling will grow. Seedlings grown in the same seedbeds were out planted to two sites, one having a site index of 93 (Experimental Forest) and the other 65 (Tombigbee). For seedlings of the same size, those growing on the better site were 90 percent taller at the end of three field growing seasons *(fig. 8).* In fact, the extreme environmental conditions represented by the Tombigbee site equalized any seedling differences established through seedbed fertility.

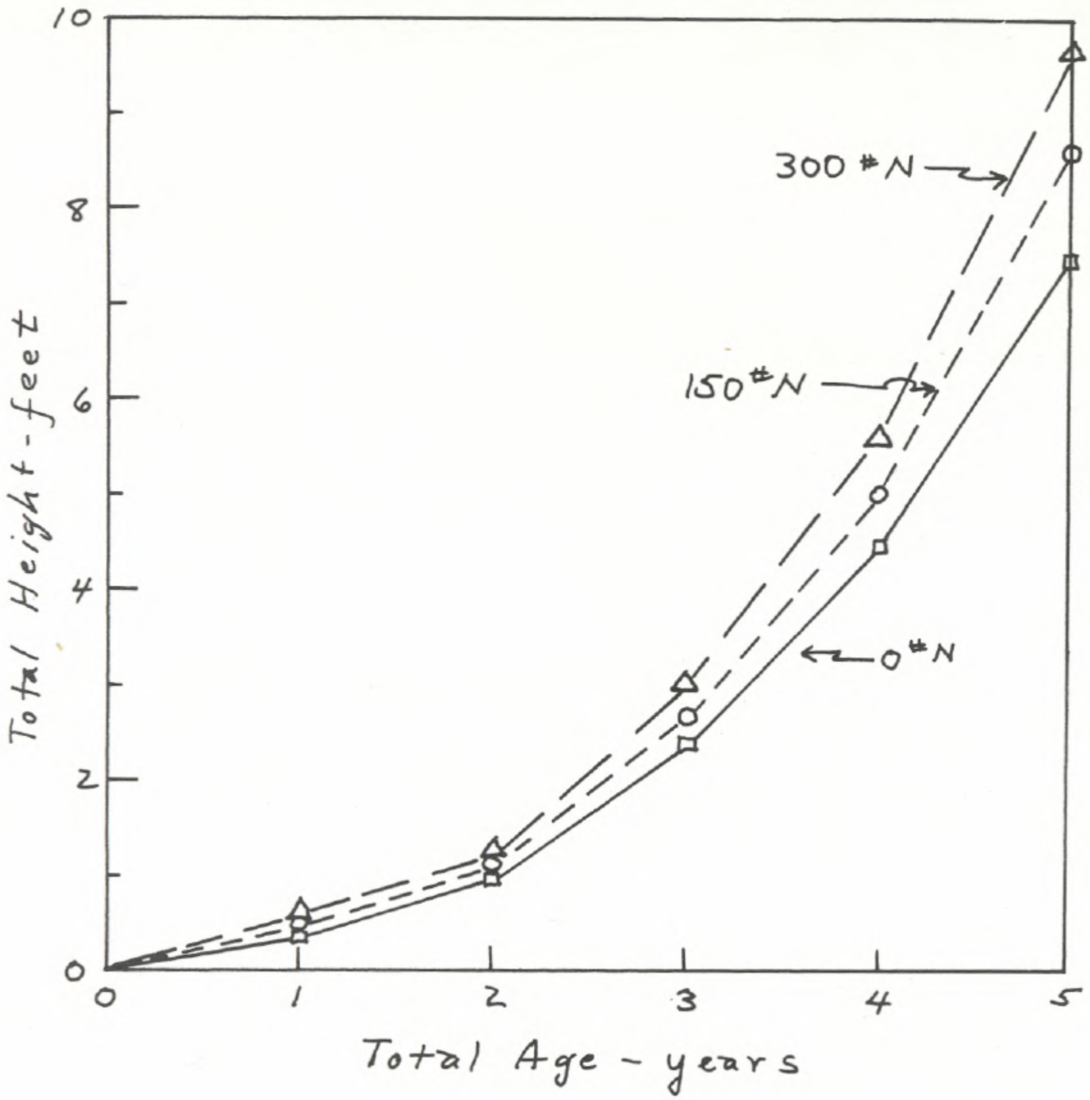

Figure 4.--The effect of seedbed nitrogen fertilization on field height of loblolly pine (1954 stock).

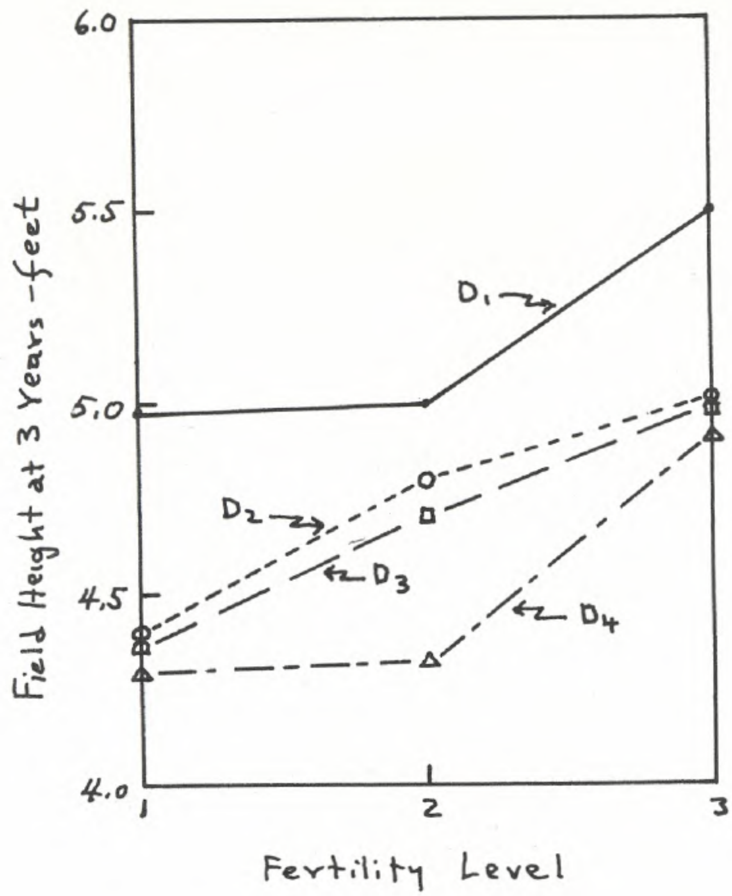

Figure 5.--The mean effect of seedbed fertility and density on the field height at 3 years. Means of 3 year's stock. The fertility levels were 75-50-75, 150-100-150, and 300-200-300 pounds of N, P205, and K20 per acre, respectively. The densities were 15, 30, 45, and 60 seedlings per square foot.

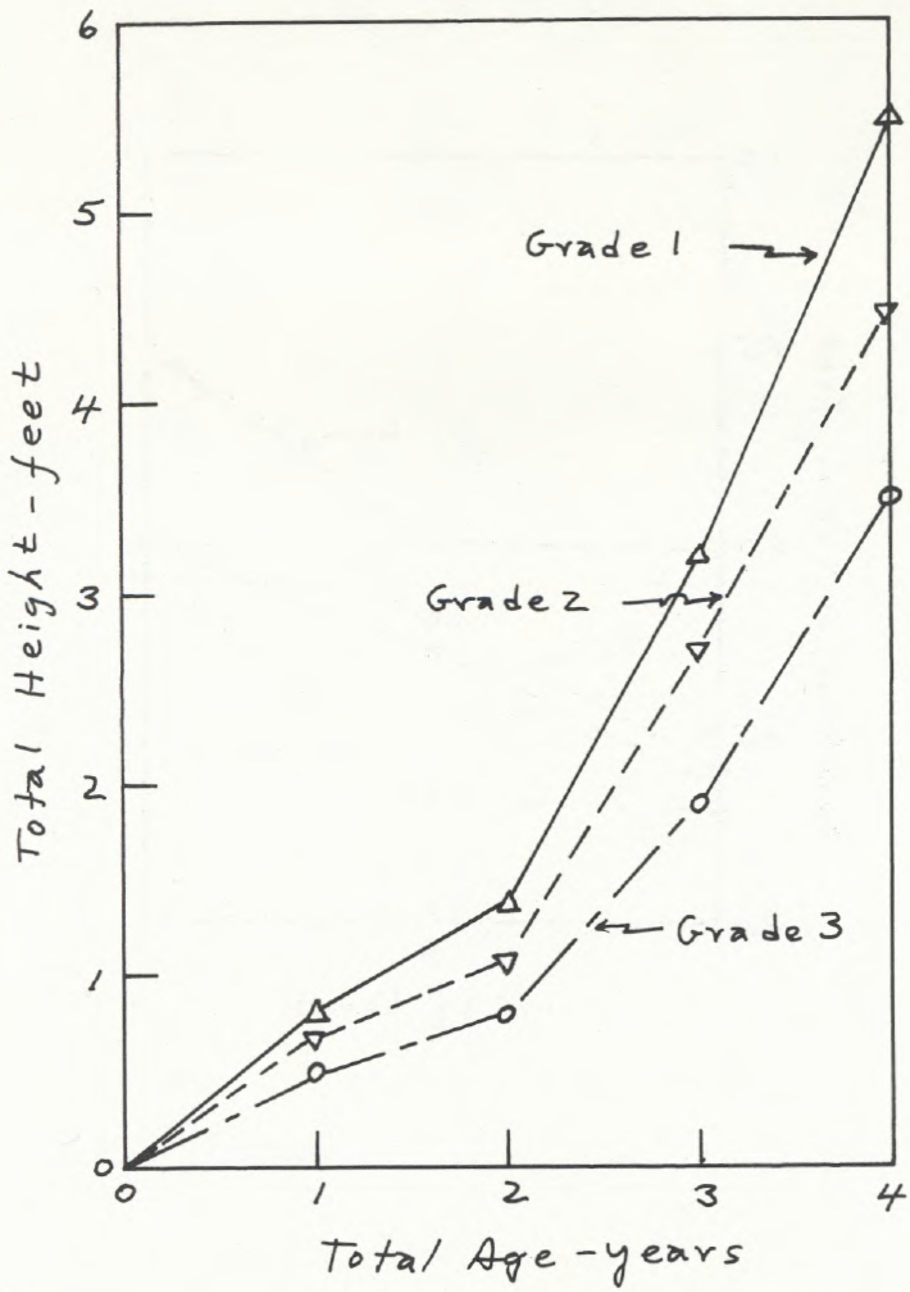

Figure 6.--Field height of loblolly seedling grades. Means of four nurseries and three levels of nitrogen.

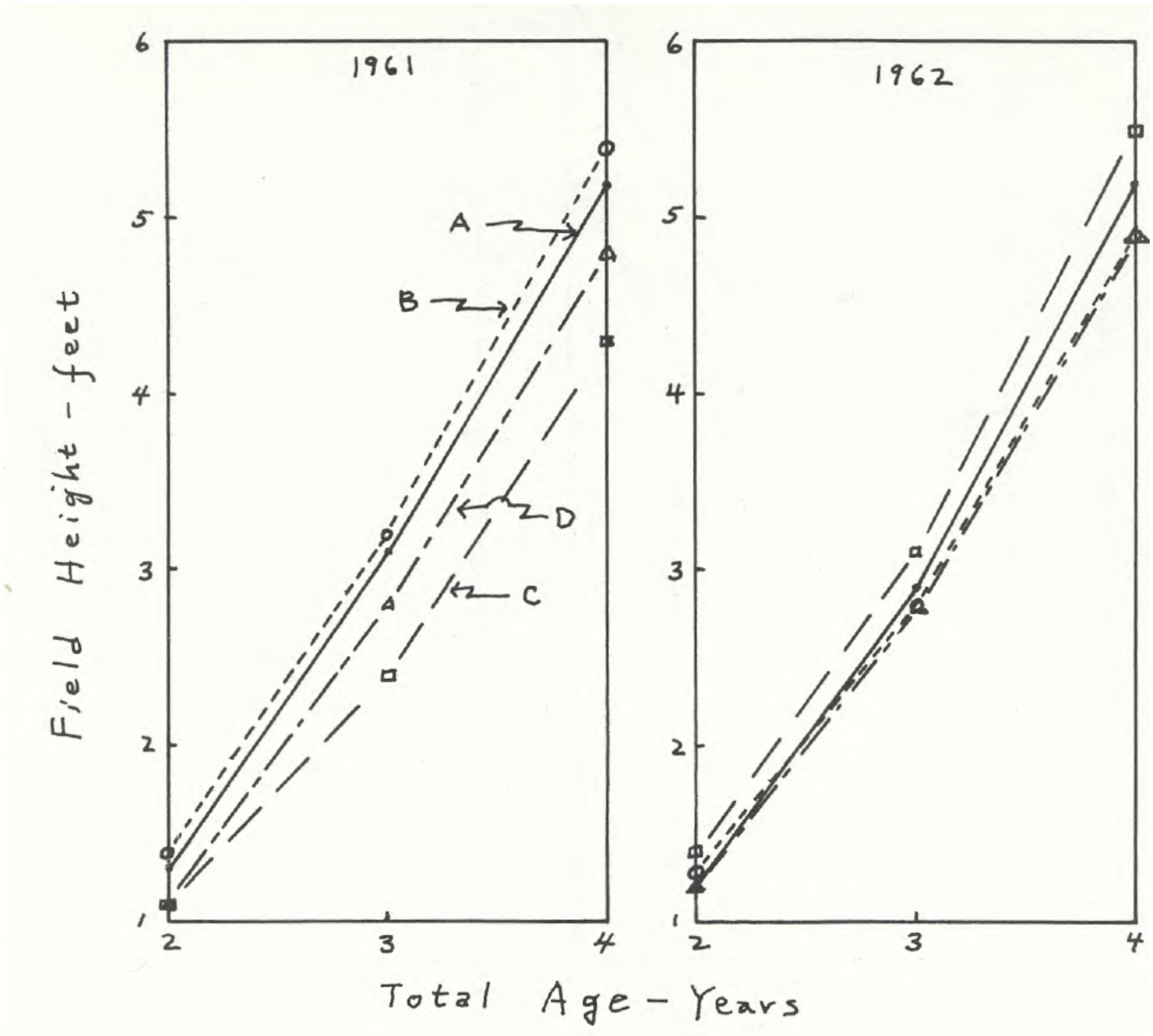

Figure 7.--Field height growth of loblolly pine (1961 and 1962 stGck) produced at four nurseries at a nitrogen level of 172 pounds per acre. Means of grades 1 and 2 (plantable).

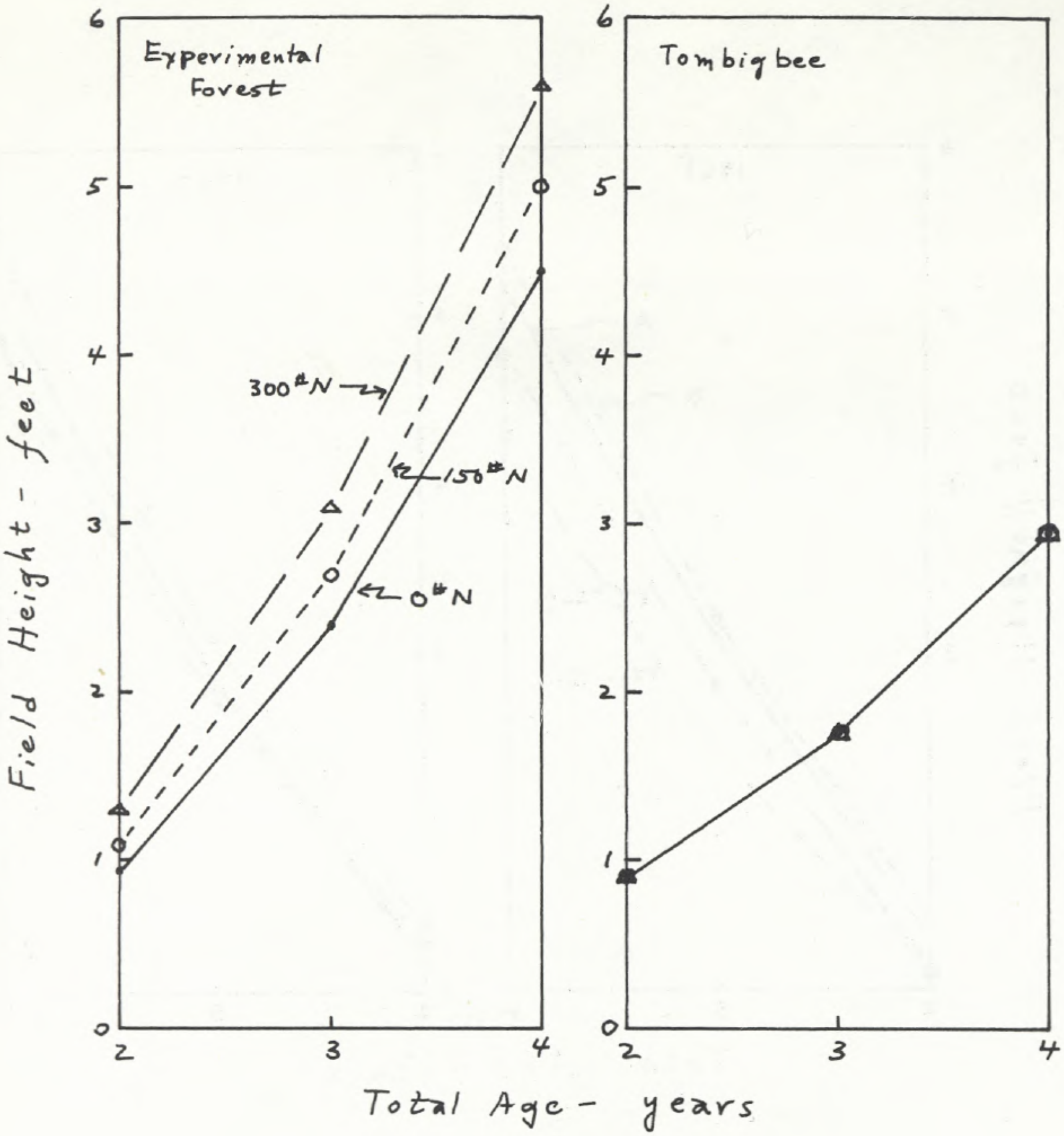

Figure 8.--The effect of seedbed fertilization on field height growth of loblolly pine planted on two sites (1957 stock of bed—run seedlings).

SUMMARY

It seems evident that there is little the nurseryman can do in terms of reasonable soil management to influence survival so long as he grows a seedling of suitable size (grade). Survival depends chiefly on how the seedling is handled from the time it is lifted until it is planted out and on the environmental conditions prevailing during establishment.

The growth of a seedling after out planting can, however, be influenced by nursery soil management. We know that field performance of the planting stock, in terms of height growth, is a function of seedling size (grade) and of its nutrient content, in our case, chiefly nitrogen. Thus, seedling quality--the quest of the nurseryman and planter--in terms of growth, is probably a function of seedling reserves, carbohydrate, nitrogenous, and others, which are very strongly influenced by nursery practice.

Acknowledgments

The writers acknowledge the assistance of the nursery personnel of the Mississippi Forestry Commission and U. S. Forest Service who cooperated in some of the studies reported here. This is not considered an original contribution since most of the data presented here have been published elsewhere by the authors.

Discussion

Q. (Cloud) Were seed sources the same?

A. (Nelson) Yes.

Q. (Farmer) Are coefficients of variation much less on poorer sites?

A. (Nelson) I don't recall for sure and I don't have the data with me.