Pine Plantation Survival: A Corporate Look at the Problem

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Abstract.--The economic impact of poor initial stocking in terms of reduced wood yield and higher per unit production costs led the Union Camp Corporation to investigate causes of low stocking in young slash and loblolly pine plantations. Low seedling quality, poor planting technique, and adverse microenvironment, each caused from 3 to 6% mortality during the first year. Loss of seedlings to insects or diseases was negligible. Missed planting spaces lowered initial stocking by almost as much as first year mortality, indicating that increased supervision may be the single most important means of approaching satisfactory stocking. The tendency for early stabilization of first year mortality in slash pine suggests that stocking may be evaluated much earlier than previously thought, but this relationship was absent in loblolly.

Keywords: Seedling mortality, Union Camp Corporation, *Pinus taeda*, *Pinus elliottii*, reforestation, plantation establishment.

Forest land managers across the southeastern United States are becoming increasingly concerned over decreasing survival rates in pine plantations. Results of a recent APA survey (Weaver, et al. 1980) found that while total planted acreage has nearly doubled (1960-64 to 1975-79) average survival rates have dropped from 83 to 73 percent. Rowan (1980) listed poor handling and planting techniques as the major causes of this mortality. Other probable causes include weather, quality control at the nursery and changing plantation establishment practices.

Concern is well justified, especially in light of the fact that many foresters, land managers and nurserymen do not fully appreciate the consequences of low initial stocking. Consider the effect on absolute yield at rotation age (Fig. 1). Assuming initial planting of 720 stems per acre, a yield difference of nearly 7 cords/acre may be realized when initial survival is increased from 60 to 80%. Production cost decreases from \$7-\$10/cord since regeneration cost remains fixed while volume increases (Table 1). Moreover, poor stocking will not enable us to capitalize on technological inovations. Future productivity gains from genetics, competition control,

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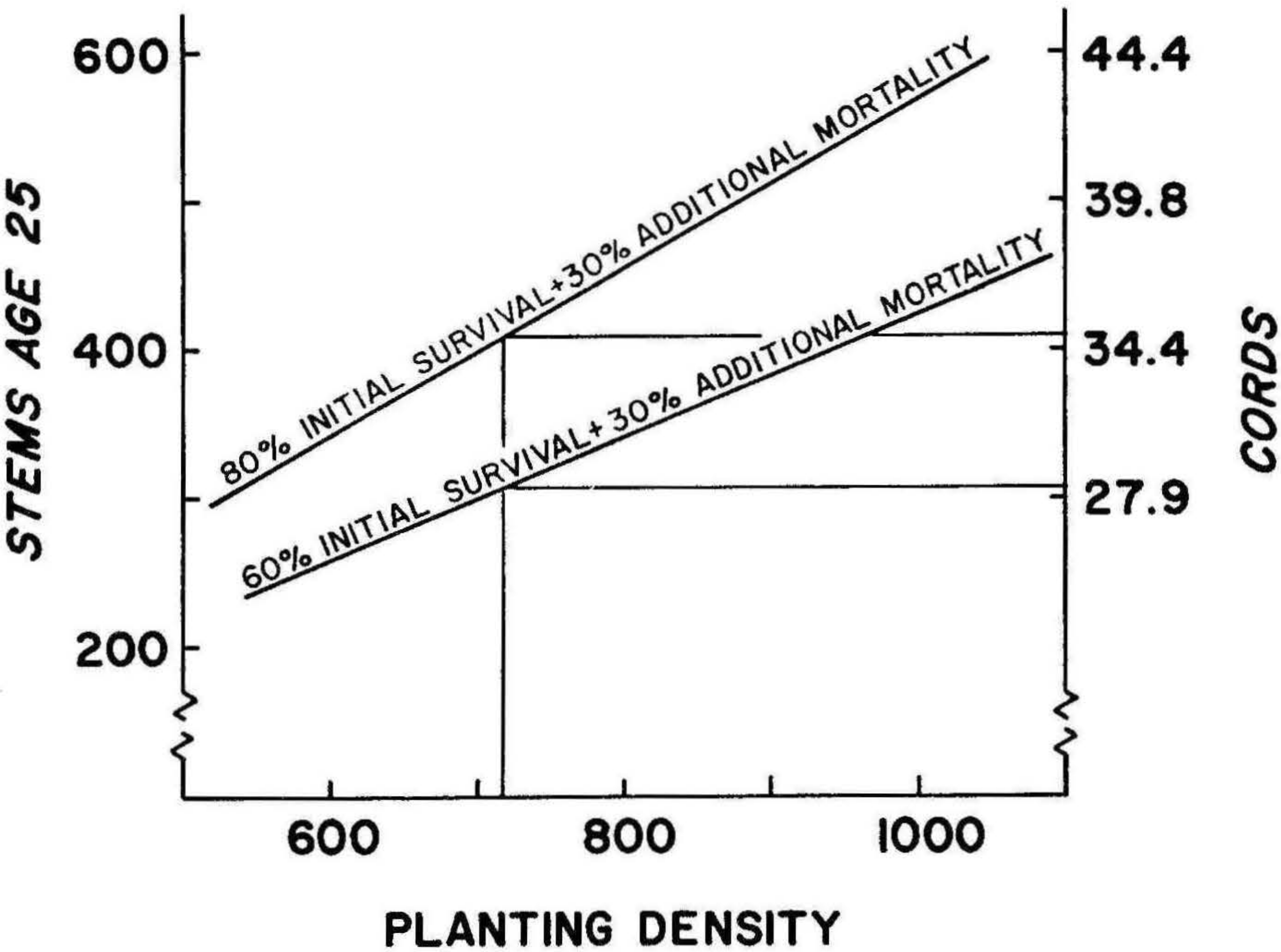

Figure 1. Effect of planting density and survival on expected volume per acre 1/

1) Loblolly pine SQ 60. University of Georgia 1982.1 Yield model.

fertilization, site preparation, drainage, etc., cannot be fully realized in understocked stands. In this paper, we report the findings of a study by Union Camp to determine the extent of decreasing initial survival on company lands.

Table 1. Effect of regeneration cost on cost per cord.

Av. Regeneration Cost/acre	SPA Age 25	Vol. Age 25 [2/]	Future cost/CD 10% interest
$90.00	300	27.9	$34.95
90.00	400	34.4	28.35
90.00	500	39.8	24.50

METHODS

Establishment of seedling monitoring plots was begun in Union Camp's Savannah operating region during the 1978-79 planting season. During the 1979-80 and 1980-81 seasons plots were also located in the Alabama and Franklin, Virginia regions. In all, 106 plantations, each containing two replicate plots were sampled. Each plot contained 72 planting spaces.

In order to give those directly responsible for planting the opportunity to closely observe potential plantation establishment problems, working circle foresters assisted the research department in the collection of data. Plots were observed monthly for one year to determine if causes of mortality could be precisely defined. Sites were classified by drainage class, land form, soil type, and site preparation treatments. Stand data on fertilization, planting method, seedling lifting and planting dates were recorded.

RESULTS AND DISCUSSION

Causes of poor stocking -- Thirty-five plots were established in the 1978-79 planting season. First year mortality averaged 17%. In addition, 13% of the potential planting spaces were not planted, resulting in a stocking figure of 73% at the end of the first growing season.

Results for the 1979-80 and 1980-81 planting seasons were similar. Mortality averaged 20%, spaces left unplanted 10%, and final stocking 72%.

[2/] Loblolly pine SQ 60 - University of Georgia 1982.1 loblolly yield model.

Only 2% of the potential planting spaces were left unplanted in the Franklin region, resulting from more extensive use of hand planting methods.

Causes of mortality -- Throughout the study, little variation was seen in the extent to which poor planting stock, inadequate planting techniques, and adverse environmental conditions contributed to mortality (Table 2). Three percent of total mortality involved seedlings judged to be of poor quality. However, an equal percentage of survivors was also composed of poor planting stock, suggesting that while seedlings of poor quality may survive at a lesser rate, the potential of a given seedling to survive cannot always be gauged by appearance (c.f. Wakeley 1954:105-108). Moreover, the same subjectivity in identifying poor risk seedlings apparently extends to diagnosing other causes of mortality. Approximately half of those seedlings judged to be poorly planted, or to be under environmental stress due to unfavorable microsite conditions, survived. While insects and diseases affected a rather large percentage of surviving seedlings (14-17%), most suffered mainly from tip moth (Rhyacionia spp.) damage, and mortality from such causes was negligible. Of surviving seedlings, 66-71% were classified as healthy at the end of the first growing season.

Table 2. Fate of loblolly and slash pine seedlings in various risk categories.

Risk Category	1978-79 Mortality(%)	1978-79 Survival(%)	1979-80 Mortality(%)	1979-80 Survival(%)
Poor planting stock	3	3	3	3
Poor planting technique	5	3	6	4
Adverse microenvironment	5	3	2	2
Insect &/or disease affected	0	14	0	17
Other [a]	4	6	6	8
Healthy	0	71	0	66

[a] Seedlings that were dead or unhealthy due to unknown causes.

Seasonal distribution of mortality -- Though some plots were established in plantations planted as early as late October, we were unable to detect any significant relationship between survival and month of planting ($P \leq 0.05$), suggesting that early planting may occasionally be successful (c.f. Dierauf 1876). However, we caution against broad application of this practice since the risk of early planting is high (e.g. Ursic et al. 1966, Cox 1969, Hill 1976). In addition, our finding is based on only three years' data in which early plantings were probably under-represented. We were similarly unable to detect any relationships between survival and seasonal rainfall or between survival and soil drainage class.

Monthly survival counts enabled us to examine the pattern of mortality within the first post-planting year. For convenience, we combined monthly data into spring (March through May), summer (June through August), and fall (September through December) categories. The mean percentage of surviving slash seedlings decreased from spring (91.1%) to summer (84.8%) but then remained constant through fall (84.7%). Spring survival rates for individual plots were also closely correlated with summer (r = 0.82, P = 0.0001, df = 26), and fall rates (r = 0.85, P $\leq$ 0.0001, df = 31), implying that fairly accurate prediction of first-year survival may be possible relatively early in the growing season.

The same trend did not hold for loblolly. Mean survival for this species declined steadily throughout the first year (spring 91.2%, summer 84.1%, fall 78.1%). Moreover, the correlations of spring survival with summer (r = 0.63, P $\leq$ 0.0001, df = 64) and fall rates (r = 0.46, P = 0.0001, df = 65) were poorer than for slash. Initially, this difference was attributed to the fact that most slash plantations were in Florida where summer rains are common, while most loblolly sites were further north where summers are drier. However, when slash and loblolly plantations on the same forest were compared, the trend was still evident.

RECOMMENDATIONS

The results of this survey are preliminary. However, there is sufficient evidence to justify several recommendations. First, our finding that missed planting spaces lowered initial stocking nearly as much as first year mortality indicates that careful supervision of planting operations is the closest expedient to satisfactory stocking, at least for Union Camp. More careful site preparation may also help in this regard, since several participating foresters commented that a fair number of planting spaces were missed because they were just too rough to plant. No single mortality factor assumed over-riding importance. All causes of mortality were individually low. Mortality of trees that were considered high risk due to poor seedling quality, adverse microsite, or poor planting technique could not be easily produced; the percentages of such trees dying were nearly the same as those surviving in each of these categories. Field personnel thus would have difficulty gauging survival potential based on seedling morphology or early plantation inspection. The subjectivity involved in such judgments argues against field-grading of seedlings.

The tendency for mortality of slash pine to stabilize during summer suggests that survival checks to determine stocking adequacy may be done relatively early in the summer with little loss of accuracy. Continued mortality of loblolly through the first year and low correlations of survival rates among seasons make early checking for this species unwise.

Again, we admonish that these conclusions are based on relatively small samples and reflect the experience of just one company. However, there does appear adequate reason for concern over inadequate survival in the Southeast. The economic importance of making even small gains in productivity is obvious, and we hope this paper will stimulate continued work in this direction.

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