AUBURN UNIVERSITY
SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE

RESEARCH NOTE 95-2

Bed Density Alters Stem Density of Loblolly Pine Seedlings

by

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INTRODUCTION:

Stem density (specific gravity) was suggested as a measure of seedling quality a half century ago. However, very little work has been published since then. The general perception is that the denser the stems the higher the seedling quality. Most commonly, however, the state of ''stem lignification'' is determined only visually, and seedlings are recommended for planting when ''stem lignification'' is completed. ''Stiff, upright plants...with dry, hardened, brown shoots...that do not wilt'' characterize conditioned, good quality seedlings.

Apart from genetic differences, seedling wood density may be affected by various cultural methods. Some research has shown that faster growth (from fertilizers for example) produce seedlings of lower relative specific gravity. There are also seasonal fluctuations in the density of loblolly pine roots and shoots: the density increases rapidly from October till February showing a decreasing tendency afterwards. Some researchers expect seedlings produced on low density beds to have higher specific gravity because well-spaced seedlings continue their diameter growth during winter, i.e. when the late wood is formed.

The objectives of this study were to (i) determine the impact of bed density and nitrogen application on seedling stem density, and (ii) to compare two methods of defining specific stem density. The term ''stem density'' will be used in this article rather than ''stem specific gravity'' to follow the International Metric System guidelines.

METHODOLOGY:

In April 1994, an experiment was established in the Union Camp Corp. nursery in Alabama to study morphological attributes of loblolly pine seedlings grown at four bed densities and two nitrogen applications. The seed was sown by hand to achieve desired bed densities of 32, 65, 130, and 260 seedlings/m^2 (3, 6, 12, and 24 seedlings/ft^2). The fertilizer treatment included 172 kg N/ha or double this amount. The other cultivation procedures involved standard application of pesticides, fertilizers, irrigation, and mechanical root and shoot pruning. This split-plot, factorial experiment was replicated three times.

The seedlings were lifted by hand in January 1995. Root collar diameter (RCD), seedling height (HT), and shoot and root dry biomass were defined for 25 seedlings per plot. Four seedlings were used from each plot to study stem density. Approximately 40 mm sections

of stems were sampled just above the first lateral. The diameter of the sections was measured at root collar. Immediately afterwards, the sections were placed in labeled vacuum flasks filled with distilled water. A vacuum (0.04 MPa) was applied until the samples were saturated with water and sank. The samples were removed from the flasks and their volume (V_G) was determined with water displacement method. Then, each sample was placed on paper tissue to remove excess of water from the stem surface and its ''green'' mass (M_G) was determined. The samples were then placed in a desiccator and dried in an oven at 110 °C temperature until constant ovendry mass (M_D) was determined (3 days). The mass of each sample was determined with a Mettler AE 200 electronic balance with 0.0001 g precision.

The specific density of the stem sections was calculated with two methods. In this study, the ''standard'' stem density (SD_S) was calculated as ratio of dry mass over green volume ($SD_1 = M_D/V_G$). Another method to calculate specific density was based on an assumption that the density of wood substance is constant and therefore specific density can be expressed with an equation: $SD_2 = 1/[(M_G/M_D)-0.346]$. Analysis of variance was followed with Tukey HSD test to compare treatment means.

RESULTS:

Morphological characteristics of the seedlings and their specific stem density are provided in Table 1. The stem density data showed that the 65 seedlings/ft^2 bed density yielded seedlings with highest stem density. This was, however, significantly different only to the stem density of seedlings produced at 24 seedlings/ft^2 bed density. Although double fertilizer resulted in lower stem density, the difference was not statistically significant. There was no relationship between RCD and stem density tested for individual bed density or for all treatments combined together.

The comparison of the two methods with a paired t-test showed highly significant ($p < 0.0001$) differences between the them. The method which did not involve volume determination, yielded stem densities 3.5% higher. This could result from accepting the constant for wood density in the calculations while sections of stems with bark were used in this procedure.

MANAGEMENT IMPLICATIONS:

Both fertilizer and bed density can effect stem density. What this means for outplanting performance is difficult to determine at this point. However, if nursery managers accelerate seedling growth with N fertilizer, stem density decreases.

Table 1. Average height (HT), root collar diameter (RCD), dry mass and stem density of loblolly pine seedlings produced at various fertilization and bed densities treatments (different letter indexes following means within a column block indicate significant ($p < 0.05$) differences between the treatments)*

Rate of nitrogen (kg/ha)	Bed density (trees/m^2)+	Seedling morphology			Stem density (g/cm^3)	
		HT (cm)	RCD (mm)	Dry mass (g)	SD_1	SD_2
172	-	24	6.4^a	9.4^a	0.322	0.333
344	-	23	6.0^b	8.7^b	0.316	0.328
-	32	23	7.6^a	13.6^a	0.318^{ab}	0.330^{ab}
-	65	24	6.2^b	8.8^b	0.330^a	0.342^a
-	130	24	6.0^b	8.1^b	0.322^{ab}	0.333^{ab}
-	260	24	4.9^c	5.7^c	0.307^b	0.316^b
172	32	23	8.0	14.1	0.314	0.325
	65	24	6.7	9.9	0.336	0.347
	130	25	5.9	7.9	0.329	0.341
	260	24	4.9	5.7	0.308	0.317
344	32	22	7.3	13.0	0.322	0.335
	65	23	5.8	7.7	0.325	0.337
	130	23	6.0	8.3	0.314	0.325
	260	24	4.8	5.7	0.305	0.314

* SD_1=dry mass/green volume; SD_2=1/[(green mass/dry mass)-0.346].
+ Divide by 10 to get approximate number of seedlings per square foot.