LOBLOLLY PINE SEEDLING VIGOR BASED ON BUD DEVELOPMENT

Jon D. Johnson and James P. Barnett[1]

Abstract - Previous research has indicated that root growth precedes and stimulates bud break in several conifer species. This relationship was used to develop a method for assessing seedling vigor in loblolly pine. Seedlings lifted monthly from two pine nurseries in Virginia were used to test the method. The method appeared to be sensitive and easy to conduct. Nursery, storage and stress treatments affected seedling bud activity (BA). Storage of the seedlings increased BA for the December- and February-lifted seedlings whereas it decreased BA for the March- and April-lifted seedlings. A uniform drying stress reduced BA in all instances, however a differential response by lifting date suggested that early and late lifted seedlings were the least sensitive to the stress. Survival was fairly uniform at 100 percent for the control seedlings, but the stress treatment significantly reduced survival in December-lifted seedlings.

Additional Keywords: *Pinus taeda*, seedling quality, storage, stress.

Seedling quality is of perennial importance to nursery managers and therefore, it is paramount to be able to assess quality. Jaramillo (1980) reviewed the various methods that have been employed to estimate seedling quality, or vigor. Of these methods, two bioassays show promise. The first is root growth capacity (RGC) which provides an estimate of the ability of a seedling to initiate new roots (Stone, 1955). Sutton (1980), however, found that although RGC influences survival and growth, the great variability encountered in his studies obscured any relationships. The second bioassay method is based upon the number of days to break bud when seedlings are placed into a uniform growth environment (Hermann and Lavender, 1979). This method has the advantage of being relatively easy and fast to conduct and the variable measured (speed of bud break) exhibits good correlation with seedling height growth(Johnson, 1982).

Root growth in trees has been known to stimulate bud break and this phenomenon appears to be related to plant growth regulators produced

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in the roots (Lavender et al. 1973; Wareing, 1980). Preliminary studies with loblolly pine (*Pinus taeda* L.) seedlings also indicated that root growth was required prior to bud break (Johnson, unpublished data). The objective of this study was to test the bud break method as an indicator of loblolly pine seedling vigor.

METHODS

Loblolly pine seedlings were operationally lifted from two nurseries located in Virginia (arbitrarily identified as nursery 1 and nursery 2) beginning in December 1983 and continuing monthly (except for January when the soil was frozen) until April 1984. From each nursery on a given lifting date, 240 seedlings were processed. One hundred and twenty seedlings were repackaged and placed into cold **storage** at 4°C for 30 days. The remaining 120 seedlings were divided in half; one group was immediately planted in two gallon pots containing peat-amended loamy sand nursery soil. Ten seedlings were planted per pot, each pot was replicated twice and the replicates were blocked thrice. The remaining group was stressed for one half hour in a forced air oven at 35° C (95°F) and 10-15 percent relative humidity. The stressed seedlings were then potted like the control seedlings., After the storage period, the seedlings were processed as described for the non-stored seedlings.

The seedlings were maintained for 20 days under 16 hour photoperiod with day/night temperatures of 24°C (75°F)/18°C (65°F). Relative humidity was kept above 50 percent. During the 20 day period the seedlings were fertilized twice with 20-20-20 Peters General Purpose fertilizer (Fogelsville, Pa) and watered regularly to maintain near-field capacity.

On the 20th day after planting, bud activity (BA) was assessed on every live seedling by assigning a numerical value as follows: 0 - no visible BA; 1 - bud swelling, no stem elongation (green scales are visible between brown bud scales); 2 - bud and stem elongation, but new needles are enclosed in fascicle sheath; 3 - continued bud elongation and presence of needles piercing fascicle sheath. Dead seedlings were not rated and therefore, pot means were based on the number of live seedlings. Mortality was tallied separately. The data were statistically analyzed using analysis of variance followed by mean separation of significant factors.

Additional data were collected on several occasions by rating the BA of individual seedlings and then counting the number of new roots initiated (RGC) during the 20 day period. For each replicate (pot) the average number of new roots by BA value was calculated. These data pairs were regressed on all replicates from control and stressed treatments for a given lifting date and storage treatment combination.

RESULTS AND DISCUSSION

The BA of loblolly pine seedlings was highly correlated with average number of new roots (table 1). Coefficients of determination ranged from a

Table 1. - Linear regression coefficients of the relationship between the number of new roots and bud activity rating for loblolly pine seedlings. The generalized equation was: BA = $\beta_0 + \beta_1$(no. new roots). The seedlings were lifted from two Virginia nurseries (1,2) on three dates and were either not stored (NS) or stored for one month at 4°C(S).

NURSERY	LIFT DATE	STORAGE	EQUATION β_0	β_1	R^2
1	84-2	S	-0.18	0.25	0.93
1	84-3	NS	0.09	0.38	0.98
1	84-4	S	-0.19	0.47	0.85
2	84-2	S	0.19	0.17	0.98
2	84-4	NS	0.40	0.27	0.93
2	84-4	S	-0.47	0.66	0.91

low of 0.85 to a high of 0.98. The slopes increased with later lifting dates and did not appear to be affected by storage or nursery. These data further support the observations that root growth must precede bud activity.

Bud activity over the lifting dates progressively increased until a maximum of about 2.2 in March-lifted seedlings (fig. 1). The BA of seedlings from

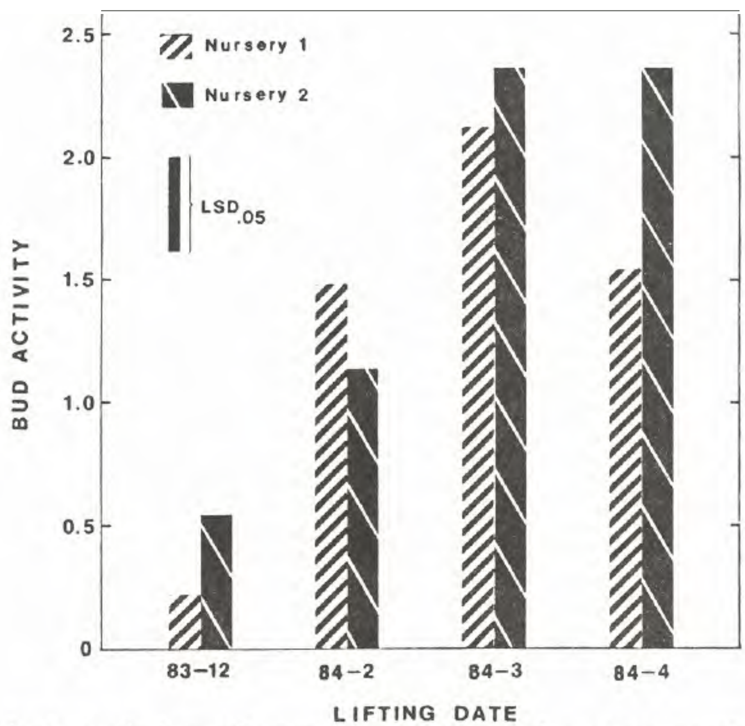

Figure 1. - The bud activity of non-stored loblolly pine seedlings over four lifting dates from two Virginia nurseries.

nursery 1 then declined in April whereas nursery 2 seedlings maintained a high BA. This trend in the BA illustrates the effect of chilling on bud dormancy in loblolly pine. Garber (1978) reported a similar trend for loblolly pine seedlings from an Arkansas source; however, the chilling requirement was met by mid-December in that study. In the present study, the chilling requirement apparently was not satisfied until the first of March. At first glance, this appears unusual since very cold temperatures occurred from late December through the end of January and presumably provided enough chilling to remove bud dormancy. However, as mentioned in the Methods section, the soil was frozen for the better part of this period suggesting that the roots may play a role in sensing the chilling hours, but only when the soil temperatures are above freezing.

Figure 1 does illustrate the sensitivity of the method to differentiate nurseries and lifting dates. Extending the growing period from 20 to 30 days for early lifting dates may increase the method's sensitivity. In the method described by Hermann and Lavender (1979) for Douglas-fir, they recommended allowing an additional 5 to 10 days for bud break of seedlings lifted before mid-December.

Both the stress and storage treatments significantly affected the BA of seedlings from nursery 1 (fig. 2). The maximum BA occurred in stored February-lifted and non-stored March-lifted seedlings. In all cases, the stress treatment

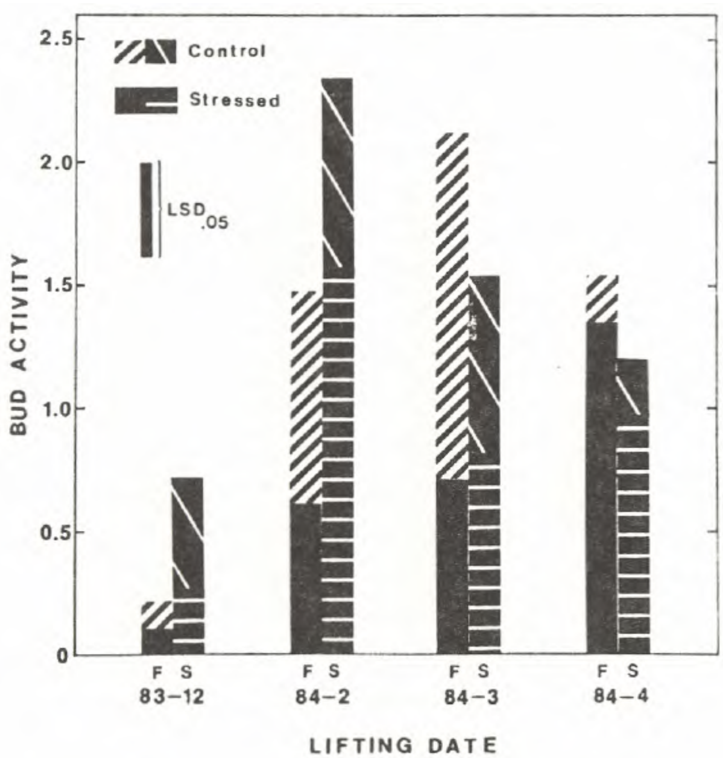

Figure 2. - The bud activity of loblolly pine seedlings from nursery 1 as affected by lifting date, storage (F - non-stored; S - stored) and stress treatment.

decreased BA, but the seedlings lifted in February and March appeared to be the most sensitive to the treatment. Such information would be useful to a nursery manager for the handling and processing of seedlings. Cold storage increased BA in the December- and February-lifted seedlings, but reduced it in the later-lifted seedlings (fig. 2). This supports the contention that the chilling requirement had not been met in the two early lifting dates.

As with nursery 1 seedlings, the seedlings from nursery 2 responded significantly to the treatments (fig. 3). The maximum BA, in contrast to nursery 1, seedlings, occurred in March- and April-lifted, non-stored seedlings. The stress treatment had a uniform effect across all lifting dates and storage treatments unlike nursery 1. Storage, as in nursery 1, stimulated BA in the early-lifted seedlings and retarded it in the March- and April-lifted seedlings (fig. 3).

Survival was nearly 100 percent for the control seedlings regardless of storage treatment. Only the stored seedling data are presented since it provided the greater separation between the control and stressed seedlings (fig. 4). Control seedling survival did drop significantly in April for both nurseries, reiterating the well known fact that non-dormant seedlings do not store well (Dierauf and Marler, 1969; Garber and Mexal, 1980). The stress treatment had

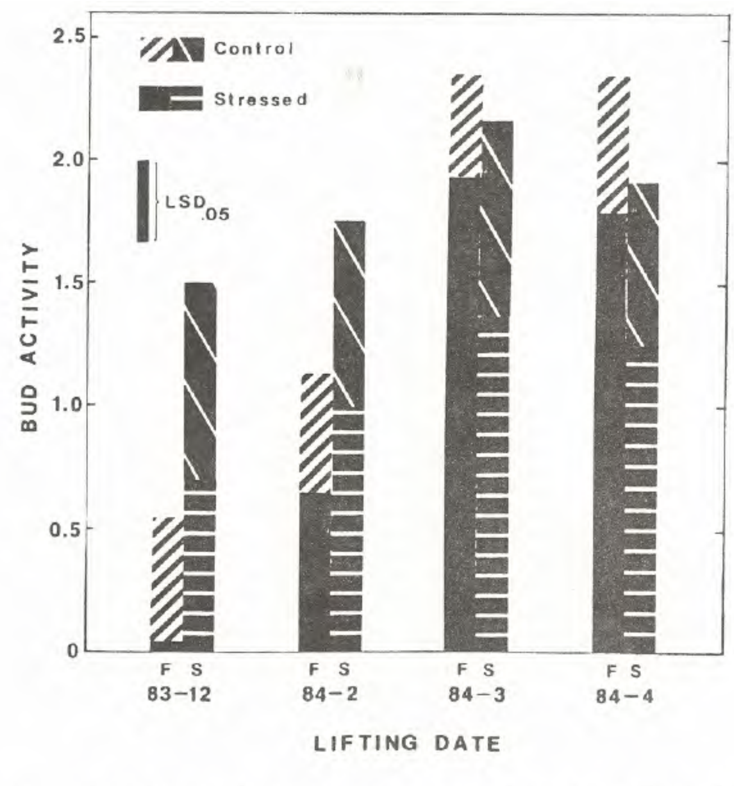

Figure 3. - The bud activity of loblolly pine seedlings from nursery 2 as affected by lifting dates, storage (F - non-stored; S - stored) and stress treatment.