ROOT GROWTH POTENTIAL - ONE TOOL FOR MEASURING LOBLOLLY PINE SEEDLING QUALITY

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INTRODUCTION

Root growth potential (RGP) of West Coast species has been extensively studied for several decades and appears to be a very useful tool for measuring seedling quality in ponderosa pine (Pinus ponderosa Laws), Douglas-fir (Pseudotsuga menziesii (Mirb.) Franco.), and other species (Jenkinson and Nelson 1983, Ritchie and Dunlap 1980, Brissette and Roberts 1984). At Virginia Tech we have been studying RGP of loblolly pine (Pinus taeda L.) since 1981 to determine the efficacy of RGP measurements as:

1. a way of measuring seedling physiological condition and

2. a predictor of field performance.

As we continue to gather data on RGP of loblolly pine seedlings we are finding that seedling RGP is sensitive to factors known to affect seedling growth and development and that RGP varies directly with the apparent physiological condition of the seedling at the time of assessment. With considerable research effort, seedling RGP could become a dependable measure of the effectiveness of nursery management and seedling handling practices which produce the physiological condition in a seedling needed for good early field performance.

PREVIOUS WORK AND PRESENT OUTLOOK

RGP has been defined as the physiological readiness of a seedling to rapidly produce new roots and thereby re-establish intimate contact with the soil. RGP may be measured by determining the number or length of new roots produced by a seedling in a controlled environment after a specified period of growth. We use two greenhouse systems for measuring RGP. One system consists of water baths maintained at 20° C into which are placed acrylic trays, each containing 15 seedlings planted in Promix®. Seedlings are allowed to grow for 24 days (16-hour photoperiod), then excavated and new roots counted and measured. The second system is similar to the above but seedlings are grown hydroponically in the greenhouse for 15 or 24 days.

Since 1981 we have conducted RGP analysis on several thousand seedlings and continue to monitor the field performance of many samples for which we have RGP data. From these data (Feret, unpublished data) we have begun formulating hypotheses about how RGP is affected by various factors and how RGP correlates with field performance. The data collected to date supports the following statements about RGP as an indicator of physiological condition of seedlings:

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1. RGP is significantly diminished in seedlings which have been intentionally desiccated or improperly stored.

2. RGP is significantly affected by several nursery practices including nitrogen fertilization, top clipping, organic matter, soil amendments, and undercutting during the growing season.

3. RGP varies significantly between nurseries and between nursery beds within nurseries.

4. RGP varies over the lifting season within any one nursery.

5. Storage of seedlings can significantly alter RGP, both positively and negatively.

6. RGP is under relatively strong genetic control.

7. Seedling size may or may not affect RGP; correlations between seedling size and RGP may be treatment specific or spurious, if they exist at all.

Perhaps the most important conclusion to be drawn from our data is that nearly everything we have investigated has produced significant variation in RGP with the exception of a study showing no differences between hand and machine lifting at the VDF nursery. That there is exceptional variation in RGP may cause some to dismiss RGP as too unpredictable to be of any use. However, the fact that so many factors affect RGP underlines its potential as a general tool for measuring the physiological condition of seedlings.

In summary, our data suggests RGP is very sensitive to factors which are known to affect the physiological condition of a seedling. Relative RGP differences among various treatments remain the same over a range of greenhouse and laboratory environments. But because absolute measures of RGP are sensitive to many factors, RGP can be compared over time only if a consistent, tightly controlled RGP analysis system is used.

From data collected to date we have formulated the following working hypotheses regarding RGP and field performance in Virginia:

Ho 1: RGP of spring planted seedlings is correlated with first- and second-year field performance as measured by: spring vigor, seedling survival, and seedling height growth increment.

Ho 2: RGP at planting time of fall and winter planted seedlings is not correlated with early field performance.

Ho 3: For fall and winter planted seedlings RGP at the start of the (root) growing season is correlated with field performance.

Ho 4: Spring planted seedlings with no root growth potential can survive but their probability of surviving and growing well in any given year on any given site is less than that for seedlings with an RGP >0.

Ho 5: Field performance and RGP relationships are most likely found under high-stress field conditions.

These hypotheses are all supported by data currently being prepared by us for publication. However, we have no data sufficiently replicated over time allowing us to accept these hypotheses without condition. Our assessment of the present outlook for RGP as a research tool is extremely optimistic, but because of the many factors and interactions affecting RGP, a major research effort is needed before a holestic model can be developed to use RGP to predict field performance.

AN EXAMPLE OF RGP AS AFFECTED BY NURSERY CULTURAL TREATMENTS

To illustrate how RGP can be modified by nursery techniques, presented here are the results of RGP tests on seedlings from an experiment conducted by T. A. Dierauf and his colleagues at the Virginia Division of Forestry New Kent nursery.

Materials and Methods

Seedlings were hand lifted December 15, 1983, stored at 4° C until analyzed for RGP. On December 20, seedlings were placed into the hydroponic system and left to grow for 24 days. RGP was measured by counting the number of new roots >0.5 cm in length. Dry weights of seedling roots and shoots were also measured.

Treatments analyzed included three organic matter (OM) supplements [0.5" (1.27 cm), 1" (2.54 cm), 1.5" (3.81 cm) sawdust rotovated into the beds prior to seeding], nitrogen (N) applied at operational and 2X operational levels (ca. 185 kg/ha and ca. 370 kg/ha, respectively), and topclipping (Level 1) and no topclipping (Level 2). The study included five replicate beds and within each replicate each treatment combination was analyzed using six seedlings. Thus, a total of 30 seedlings/treatment combination was used.

Data analysis was accomplished using chi square analysis and Duncan's multiple range test to separate treatment differences. Chi square analysis was made of seedlings grouped into three categories according to the number of new roots recorded. Seedlings with 0-5 new roots were classed as "poor" (P), 6-10 new roots as "good" (G), and $\geq$11 new roots "excellent" (E).

Results

Chi square analysis (Table 1) of categorized seedlings showed significant main effects and no treatment interactions (confirmed with ANOVA). Therefore, results are presented by considering main effects only.