MONITORING GROWTH PROGRESSION THROUGH ROOT COLLAR DIAMETER MEASUREMENTS

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ABSTRACT

Four years of root collar diameter growth progression monitoring of 1+2 (1.5+1.5) and 3+0 black spruce (Picea mariana (Mill.) B.S.P.), 2+2 and 3+0 white spruce (Picea glauca (Moench) Voss), and 2+0 jack pine (Pinus banksianna (Lamb.)) are analyzed and discussed. The modified Weibull function provided excellent correlation coefficients for transplant stock (r^2 = 0.973 to 0.942) and for seedbed stock (r^2 = 0.916 to 0.881).

The application of these regression curves to the fore-casting of stock size and quality is possible only while monitoring the growing season and noting the fluctuating properties of root collar diameter.

INTRODUCTION

The production of morphologically uniform nursery stock in any one year and from year to year is essential to the determination of desired stock types of plantation establishment. Variation between years may result in the planting of morphologically undesirable nursery stock or stock of poor physiological quality. To ensure superior morphological quality, growth progressions through the growing season must be understood. To effect necessary changes, we must have an understanding of where we should be with respect to growth at all times. By identifying inherent growth patterns of the various stock types produced in any nursery, we will be able to change cultural practices in order to modify the growth pattern to achieve the desired outcome. To this end, growth progession monitoring was undertaken at the Thunder Bay Forest Station. Root collar diameter (RCD) was used as the attribute of growth increment because of the limited variation and the smaller sample size required.

METHOD

Growth progression monitoring was carried out following the guidelines provided by the Ontario Ministry of Natural Resources in "Quality control procedures for nursery stock production."

RESULTS

Analysis of the data was performed using linear and modified Weibull functions. The RCD growth progressions were returned to the origin to enable us to analyze the growth pattern of the present year regardless of the preceding years.

The modified Weibull formula was superior in fit (r^2) to the linear function because of its ability to accommodate a slow spring start and a gradual tapering off to completion at the end of the growing season. Only the modified Weibull function will be discussed here.

The modified Weibull function formulaes all had excellent correlation coefficients (Table 1). Transplant stock was more uniform than seedling stock within and between years due to density, available moisture, and variation in cultural practices.

In the transplants, PIm 1+2 and PIg 2+2, variation was minimal over the first 100 days of the growing season. From then on variation increased, with the result that total growth (Table 2) varied from year to year. Measurements taken in April, May, or June would be the basis for any changes in cultural plans. The uniformity of growth at this time and the erratic nature of growth later in the season would make monitoring early in the year profitable for locating the origin, but the adjustment of plans would be questionable. Variation in the growth rate does not occur until July. At this time it is usually too late to effect any change.

The seedbed stock, PIm 3+0, PIg 3+0, and PNb 2+0, exhibited variation from the onset of growth. This may be explained by the variety of densities under which the stock was grown. Seedbed stock also showed growth reductions that appear to have been caused by climatic conditions.

The RCD in the seedbed stock increased and decreased erratically following weather patterns. In periods of hot, dry days, RCD decreased and then increased when wet weather returned. The transplant growth progressions were affected similarly, athough no reductions took place.

DISCUSSION

Root collar diameter is affected by xylem pressure potential (Hinckley et al. 1974). On days in which xylem pressure reached 25 bars, the diameter upon rehydration was less than that prior to dehydration. During periods of severe drought, as experienced in the spring of 1980, diameters of all ? ecies displayed a decrease or slowing in growth. Daytime temperatures in excess of 30 C and relative humidity of less than 20% for an extended period were responsible for poor correlation. Height growth and presumably dry weight increases were occurring at this time, but RCD measurements were not indicating this. When an extended spring drought occurs, common in our region every 4 or 5 years, the RCD measurements are relatively difficult to assess and the alteration of the cultural operation plan is impractical since we are not certain of the actual growth progression (dry weight).

Nursery practices dictate that irrigation and nitrogen be reduced in August to induce dormancy and bud set. This leaves a period from May 1 to July 31 to change the cultural plan for the purpose of increasing growth. When a spring drought of 4 to 6 weeks negates the monitoring of growth progressions, there is little chance of successfully altering the growth to the desired outcome in the remaining time.

CONCLUSIONS

The use of RCD measurements for growth progression is impractical in regions such as ours, where extended periods of drought render them uninterpretable. Data

Table 1. Weibull function curves r^2 values for five stock types

Species	Age	Weibull formula	r^2
bS	1+2	$Y = 3.20\ (1-e^{6.524.06\ x^{2.574}})$	0.973
bS	3+0	$Y = 3.00\ (1-e^{1.401.04\ x^{1.799}})$	0.881
wS	2+2	$Y = 2.81\ (1-e^{1.712.07\ x^{3.380}})$	0.942
wS	3+0	$Y = 2.30\ (1-e^{2.693.05\ x^{2.285}})$	0.916
jP	2+0	$Y = 2.21\ (1-e^{5.615.06\ x^{2.557}})$	0.911

Table 2. Total growth for each year for five stock types

	Total growth (mm)				
Stock type	bS 1+2	bS 3+0	wS 2+2	sW 3+0	jP 2+0
1977	3.08	1.60	2.40	-	-
1978	2.67	2.29	2.80	2.10	2.05
1979	3.08	2.45	2.80	2.15	2.20
1980	2.72	2.45	-	1.70	1.20

Table 3. Production of density monitored seedbed stock

	Density (m^2)		
Stock type	bS 3+0	wS 3+0	jP 2+0
1977	368.1	-	-
1978	143.1	152.7	292.2
1979	267.4	33.3	309.6
1980	294.6	303.4	364.3
Desired	432.0	432.0	372.0

collected thus far will be beneficial in years when droughts do not occur. The curves, however, must not be taken literally but a gray area of plus or minus 10% of the curve must be observed before making any alterations.

REFERENCES

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