Root Growth Capacity Effects on Field Performance[1]

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Abstract.--Good field performance (first year survival) was found for interior spruce (Picea glauca x engelmannii) or lodgepole pine (Pinus contorta) seedlots that had average root growth capacity (RGC) levels greater than 10 new roots longer than 10 mm per seedling. The RGC-field survival relationship was affected by both species and planting year, but not so much by planting site.

INTRODUCTION

Since 1977 forest nurseries in British Columbia have routinely determined the root growth capacity (RGC) of batches of nursery stock. The method usedis similar to that described by Burdett (1979). For the major species planted in British Columbia, correlations between RGC and field performance (survival and/or growth) are often found (Burdettet et al. 1983; van den Driessche 1983; Simpson unpubl.).

Beyond merely assuming that a higher level of RGC is better than a lower level, interpretation of RGC test results has been difficult. A number of factors act to confound interpretation including: sampling problems, large tree-to-tree variation, suitability of test duration and conditions, uncontrolled or unknown variations in other physiological and morphological characteristics which may affect field performance, and interactions with planting site environment.

The purpose of this experiment was to determine the nature of the relationship between RGC and field performance for interior spruce (Picea glauca x engelmannii), lodgepole pine (Pinus contorta) and interior Douglas-fir (Pseudotsuga menziesii var. glauca) on a range of ecologically different forest planting sites in British Columbia's southern interior.

THE EXPERIMENT

To establish relationships between RGC and field performance, it is necessary that batches of stock ranging in RGC from none to many roots per plant are available and that these batches of stock are planted at the same time and on the same planting site.

In this experiment, batches of stock with a wide range of RGC were obtained from cold storage after reviewing the BC Ministry of Forests' RGC testing results. For each species (interior spruce, lodgepole pine, and Douglas-fir) 20 to 30 batches of stock (seedlots) were identified and shipped to the Kalamalka Research Station near Vernon, B.C. The stock was re-packaged and RGC re-measured shortly prior to establishment of outplantings.

The RGC testing procedures were similar to those described by Burdett (1979). Seedlings were potted in 3:1 peat-vermiculite soil mix and grown for 7 days in conditions providing 18-hour days (400 umol/m^2/s), 30°C-day and 25°C-night temperatures. The root growth assessment procedures differed only in that the total number of newly elongated roots longer than 10 mm on each seedling was recorded.

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Between 1985 and 1987, 18 plantations were established on a range of forest site types in British Columbia's southern interior (table 1). Each outplanting consisted of three blocks with 20 to 30 rows of 25 seedlings. The order of rows was randomized within each block.

Table 1.--Outplanting sites

	Site Type[1]	Planting year
Interior spruce	ICHe2	1985
	ICHml	1986
	ESSFm	1986
	ESSFd4	1986
	MSBl	1987
	ESSF	1987
	ESSFm	1987
Lodgepole pine	ICHml	1986
	ESSFd4	1986
	ICHm2	1987
	ICHal	1987
Douglas-fir	IDFb	1986
	IDFb	1986
	ICHm2	1986
	IDFb	1987
	IDFb	1987
	ICHe2	1987
	ICHal	1987

[1]Site types as described by the biogeo-climatic system used by the B.C. Ministry of Forests.

RESULTS AND DISCUSSION

In most cases the relationship between RGC and first year field survival for interior spruce and lodgepole pine but not interior Douglas-fir was asymptotic in shape (for example, fig. 1). Regression lines could be drawn through these scatter of points to indicate the proportion of survival variation that is a function of variation in RGC. While these type of curves are useful to show the nature of the relationship between RGC and field survival, they are not as useful for interpreting RGC data or more simply for determining an acceptable level of RGC for batch culling.

A more useful approach may be to consider various RGC threshold levels and then to examine the field survival of batches above and below those thresholds. The data in figure 1 suggest for those plantations a natural threshold exists at around a RGC level of 10 roots per plant.

When a threshold of 10 roots greater than 10 mm per plant is applied to the data obtained in this experiment (figure 2) the following observations can be made:

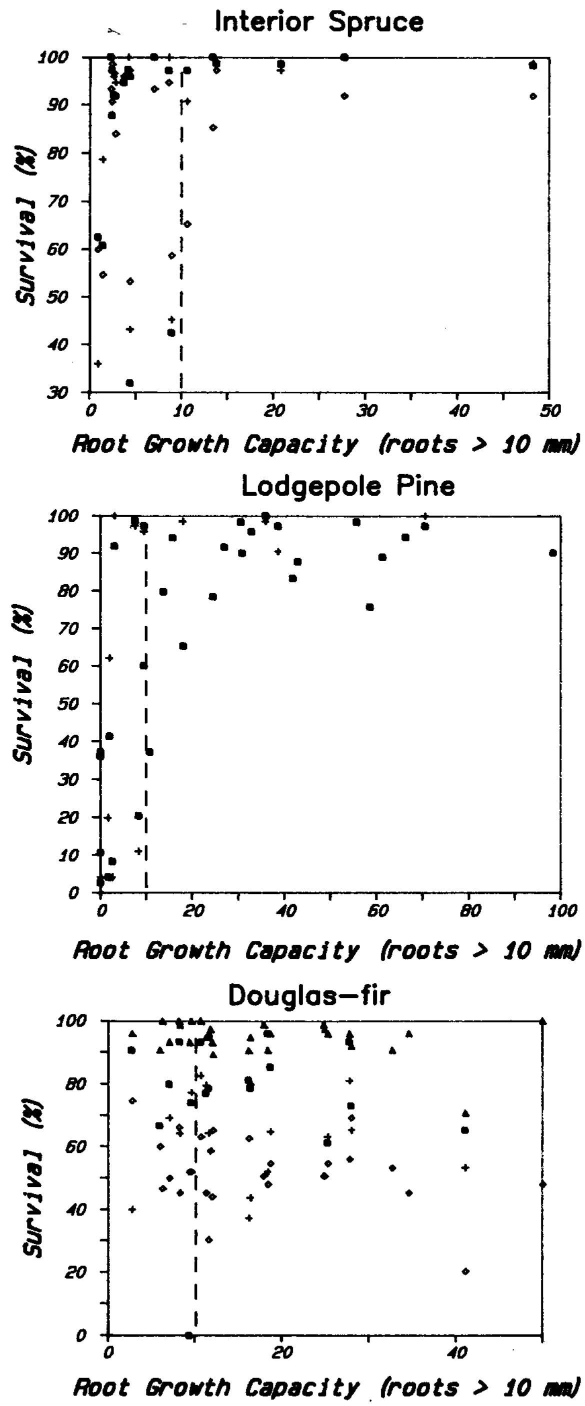

Figure 1.--First year field survival (%) of Interior spruce, lodgepole pine, and Douglas-fir seedlings planted in 1986. Each point represents the mean RGC of a 20-seedling sample and the mean field survival of 75 seedlings.

1. Planting batches of stock with RGC levels greater than an average 10 roots per plant results in generally higher survival with less variation or chance of poor survival.

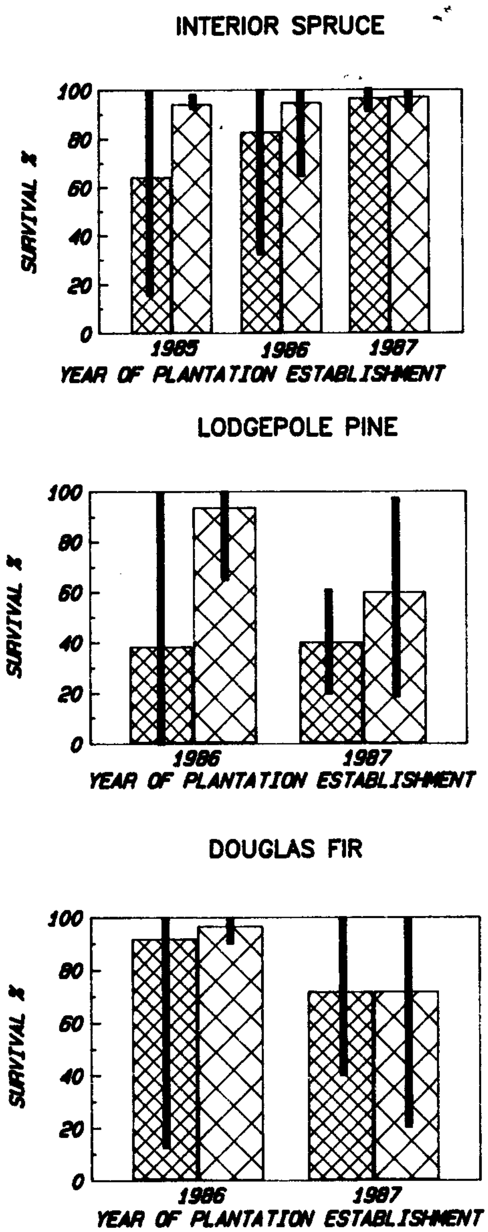

Figure 2.--First year field survival (%) of interior spruce, lodgepole pine, and Douglas-fir planted between 1985 and 1987. Bars represent mean RGC for seedlots with RGC's less than 10 roots per plant (narrow cross hatch) and greater than 10 roots per plant (wide cross hatch). Range of seedlot means is indicated.

2. There is an interaction with planting season; in some years RGC is not of predictive value in determining field performance.

3. There is a species interaction wherein the relationship between RGC and survival for both interior spruce and lodgepole pine seems similar, but there seems to be no relationship in Douglas-fir between RGC and survival. It is unclear why no relationship between RGC and Douglas-fir survival was found.

4. The RGC-survival relationships, at least for the first year, are little affected by planting site.

CONCLUSION

The data presented here suggest a natural RGC threshold of an average 10 roots per plant greater than 10 mm in length could be used as a batch culling guideline to ensure higher survival and less chance of plantation failure for interior spruce and lodgepole pine planted in British Columbia's southern interior. Barring unusual circumstances, seedlots whose RGC levels are greater than an average 10 roots per plant will survive very well on outplanting.

Due to the large survival variation in seedlots planted with RGC levels less than 10 roots per plant, it is expected that such a threshold, or batch cull level, if implemented in practice will result in destruction of some batches of stock which might in some circumstances have adequate field performance. The cost-benefit of batch culling based on low RGC levels should therefore be considered very carefully by forest managers before embarking on such a program.

Rather than using a batch culling program based on RGC (or some other aspect of stock quality), it would be more constructive to manipulate nursery cultural, cold storage, and stock handling practices to ensure that no batches of stock have RGC levels less than 10 roots per plant.

The results presented also support the need for further investigation of other stock quality measures to augment the widespread use of RGC testing.

LITERATURE CITED

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