Harrop Nursery
6320 Harrop Procter Hwy, R.R. 3, S20, C44, Nelson BC, V1L 5P6Tel: (250) 229-5353; Fax: (250) 229-4254; Email: harrop@prtgroup.com

THE EFFECT OF SEEDLING SIZE ON FIELD PERFORMANCE

There are a number of material attributes which can be measured to quantify seedling morphology, with the most commonly measured attributes being height and root collar diameter (RCD). Numerous trials (see specific examples below) comparing initial seedling size with field performance, as measured by survival and growth, have been conducted. Indirectly, height provides a measure of photosynthetic and transpirational area. As seedlings overcome competing vegetation mainly by achieving greater size which reduces light to the competition, greater height is an advantage on sites where brush competition is a potential problem. Root collar diameter is a measure of general seedling durability, and has been regarded as the best single predictor of field survival and growth. Along with height and RCD, the height: diameter ratio is thought to be an important stock characteristic which influences early plantation performance.

Although under favorable conditions large seedlings, regardless of the size standard used, generally grow better than smaller seedlings; there has been some contradiction in trials relating seedling size to field performance. However, larger stock often does not survive as well as smaller stock. Some of the inconsistencies between various morphological studies may be due to varying growth limiting factors on the numerous planting sites that have been tested. For example, on dry sites where brush competition is not excessive but desiccating winds are prevalent, smaller seedlings may be preferred as a smaller foliar surface area would tend to place less transpirational demand on the root system.

When comparing trial results, differences in the type of seedling (i.e. bareroot vs. transplant vs. container) should also be considered. As well, the parameters being compared must be clearly identified. Some of the earlier studies have compared different size seedlings from the same container or seedbed, which is not the same as comparing seedlings from different size containers. Differences in seedling size among similar containers may result from variations in growing conditions within the nursery, and or from genetic differences among the seedlings. There are also species differences, as demonstrated in a stock type trial in the sub-boreal spruce biogeoclimatic zone east of Prince George. In this trial, there was a tendency for growth rate to be related to size at first measurement in white spruce, although in lodgepole pine, growth rate was independent of tree size at first measurement. Another possible reason for contradictory results among stock type trials may be that seedlings are not in the same physiological condition when tested, as “physiological condition can override morphology”.

The use of larger stock requires greater expense up front, but overall, its use may result in greater savings in the long run. For the first few years after planting, initial savings may be realized through a reduction in the amount of weed control required. Attempts to develop a cost: benefit model to compare the alternatives of using various stock types on overall plantation establishment have been initiated. In addition, just how much is it worth if a larger stock type is partially responsible for preventing a plantation failure or avoiding a costly fill plant? The effect of stock type on plantation growth is often long-term (see specific examples below), sometimes increasing even more as time goes by. For example, larger stock was shown to attain a height of six metres 0.6 to 8 years sooner than comparable smaller stock on the same site, which means that the trees from the initially larger stock types, will reach merchantable size years before trees from the smaller stock. It has been said that the use of large stock with appropriate site treatment (if required) "could be like good seed – it does not cost, it pays!". Stock type selection should be looked at on a site specific basis, but as a general rule the literature shows that on productive, brushy sites, bigger is better.

SPECIFIC EXAMPLES - CONTAINER

- BCMOF SX 83108G. Outplanting of experimental large stock (PSB 615 and PSB 415?) from Thornhill Nursery. Trial established in 1983 on high brush sites (fireweed, alder, willow) at Mackenzie and Purden Lake. Two year survival was high for both stock types (89.6% for the 415?, 96.0% for the 615). The 1985 progress report stated that "statistical analysis of the data reveals that there is significant difference between the two stock types in relation to incremental height growth and root collar diameters."

- BCMOF SX84107G. Interior spruce survival and growth performance by height and caliper classes. PSB313 container stock was separated into 12 height/RCD stock classes and planted on an alluvial and upland site. The 1989 progress report indicates that the Fort Nelson trials show a general tendency for growth increases as size class increases.

- BCMOF SX85102Q. Three way sort interior spruce trial at Wansa Lake southeast of Prince George. Nursery stock PSB313A was graded into three RCD classes of: < 2.4 mm; 2.4-3.0 mm; and > 3.0 mm. After five seasons, survival was high (> 95%) in all classes, and root collar diameter and increment were still significantly different between each of the three classes. The largest RCD class had the greatest height at time of planting, which was still significantly greater in total height five years later.

- Field performance of five interior spruce stock types with and without fertilization at time of planting. Five stock types including PSB615, 415?, and 313? interior spruce were planted in the ICH in the Cariboo. The 615 stock was significantly taller and had greater RCD than the 415 and 313 at time of planting and still maintained this height and RCD superiority five years later.

- Influence of styroblock container size on field performance of Douglas-fir, western hemlock, and Sitka spruce. Douglas-fir, western hemlock, and Sitka spruce were grown as both a Styro-2 (40 cm^3) or Styro-8 (125 cm^3) and planted on western Vancouver Island. Survival was similar, "however, the taller Styroblock-8 seedlings grew faster over the five-year test period".

- First- and second-year survival of containerized Engelmann spruce in relation to initial seedling size. Engelmann spruce grown in 150 cm^3 Leach cells were divided into six RCD classes prior to planting on a high elevation site in Utah. "Snow-related effects were by far the greatest single factor affecting second year mortality"; and "increased survival of seedlings with large initial caliper reflect decreased susceptibility to bending and breaking by snow".

SPECIFIC EXAMPLES - BAREROOT/TRANSPLANT

- Survival and growth of four Douglas-fir stock types 21 years after planting. A trial comparing four bareroot coastal Douglas-fir stock types was re-evaluated after the 21st growing season, and differences in survival and height among stock types observed at three years remained almost unchanged 18 years later. It was recommended that "large Douglas-fir stock be used where large trees are desired soon".

- Field performance of several tree species and stock types planted in mountain forests of coastal British Columbia. In a stock type trial involving several species and stock types in mountain forests of coastal B.C., "the initial height of the [bareroot, plug-transplant, and container] seedlings did influence height 13 years after planting". "Should the same percentage of difference among stock types persist to rotation age, then the use of large seedlings of ecologically suited species would be the preferred planting option. The benefits of seedling size must, however, be balanced against the added costs of producing, transporting and planting progressively larger stock types".

- Restocking with Sitka spruce on uncultivated grey soils-the effects of fencing, weeding and initial plant size on survival and growth. Seedlings (assumed to be bareroot) were sorted into a small (10-20 cm) or large (20-50 cm) class prior to planting. "Survival and height growth of small plants were poorer than that from larger (20-30 cm) plants, although intensive weeding can offset some of the disadvantages". It was also noted that small seedlings were more badly damaged by frost compared to the larger seedlings.

- Tall planting stock for enhanced growth and domination of brush in the Douglas-fir region. Two long-term trials followed the growth of container (60 ml rigid plastic; including bullets), bareroot (2+0) and transplant (1+1; 1+2; 2+1)

Douglas-fir and western hemlock after planting in the Central Oregon Coast Range. On these rich growing sites "the probability of being overtopped by brush decreased with increasing initial stock height, and the effect of suppression on growth was also inversely related to initial height".

- Effect of initial seedling morphology and planting practices on field performance of jack pine 6 years after planting. In a trial in Ontario, the eight year total heights of out planted undersized container jack pine averaged 38% less than the heights of seedlings meeting specifications, thus it is recommended that undersized jack pine container stock not be planted.

- Effect of initial mass of white spruce and lodgepole pine planting stock on field performance in the British Columbia interior. White spruce and lodgepole pine was grown as a 2+0 bareroot, 2+1 transplant, or Styro-2 (40 cm^3) container, and graded into various size classes on the basis of fresh weight. "In general, after three growing seasons, *large* seedlings or transplants outperformed *small ones*". "The more intense the competition from surrounding vegetation, the greater the advantage of using large stock". "Large stock on untreated plots outperformed small stock on scarified plots, indicating a potential *trade-off* between stock size and site preparation, which through stock grading, may be exploited by the silviculturist".

- Effects of Douglas-fir 2+0 seedling morphology on field performance. Bareroot 2+0 Douglas-fir seedlings in Oregon were sorted into four RCD classes and three root system categories. "Initial seedling diameter and root size had a significant impact on seedling performance …". "Each additional mm of initial diameter generally increased survival by 5-15 percent and height at four to five years by 10-30 cm, depending on the site and overall level of performance. Survival was approximately doubled between the smallest and largest diameter classes."

- First-year survival of morphological graded loblolly pine seedlings in central Louisiana. Bareroot loblolly pine in central Louisiana was graded into three RCD classes prior to planting. The middle RCD class of seedlings had the greatest first year survival, thought to be influenced by the fact that there was a severe drought the year of planting.

- Overtopping by successional Coast Range vegetation slows Douglas-fir seedlings. After seven years, "both stock type and initial seedling height were good predictors of early growth" when comparing various stock types of Douglas-fir in brush prone sites in the Coast Range of Oregon. It is suggested that "selecting the largest practical transplants, coupled with site preparation that removes fast sprouting hardwoods, will reduce later [growth] losses to suppression".

- Morphological grading of white pine nursery stock. Height, RCD and root volume of 3+0 bareroot and 2+2 transplant white pine and white spruce were found to be ”highly significant predictors of subsequent performance in terms of early plantation height (at five and six years respectively).” Larger seedlings at planting were generally still larger five years later.

- Interaction of stock type and site with three coniferous species. Various stock types (i.e. 2+0, 3+0 bareroot and 1.5 + 1.5, 1+2, or 2+2 transplants) of white spruce, white pine, red pine were planted on several sites with large variation in the degree of vegetation competition. “Stronger, more robust seedlings performed better than less robust seedlings on all sites but these differences increased with increasing vegetative competition.”