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Intermediate Transplanting of Black Spruce Mini-plug Seedlings into Paperpots

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Black spruce (Picea mariana *(Mill.) B.S.P.) were grown in Castle and Cooke Mini-plugs and transplanted at 8 weeks into FH508 paperpots. Mean dry weight of transplanted Mini-plug seedlings was nearly three times that of their nontransplanted counterparts after 14 weeks. However, mean dry weight was only 45% of that of seedlings grown continuously in FH508 paperpots, and size and weight were closer to those of seedlings grown in FH308 paperpots.* Tree Planters' Notes 40(2):18-21; 1989.

Greenhouse space limitations and unit production costs often become a major source of concern for growers whenever larger containers are needed to grow larger seedlings. Although we know that seedling morphology is strongly influenced by plant spacing and rooting volume, a compromise is frequently struck that leads to selection of a container that is still too small, especially in diameter, for the revised crop specifications.

Although the idea is not new, an attractive alternative approach to growing larger stock is to start seedlings in small containers ("mini-plugs"), and to transplant them into the optimum final container at some later date. In northern climates, costs incurred in the production of 1-year-old or older spruce container stock are highest in early spring when crops are being germinated and grown in heated greenhouses. In comparison with conventional practice, a growing regime based on intermediate transplanting would allow high seedling densities during this period of highest greenhouse operating costs. This would thereby reduce the requirement for heated greenhouse space and perhaps lower the unit cost of the final shipped product. As an added economic benefit, intermediate transplanting has the potential for ensuring full stocking within trays of containers during the remainder of the growing period.

This note describes a preliminary trial to test the use of miniplugs for transplanting black spruce (*Picea mariana* (Mill.) B.S.P.) seedlings into Japanese paperpots. The commercially produced mini-plug was developed in California for use in the vegetable and bedding plant industries (Castle and Cooke Transplant Techniculture, Inc., Salinas, CA). The plug consists of a peat moss substrate stabilized with a nontoxic, rubber-like binder, which produces a cohesive yet porous plug with a preformed sowing cavity. This high-density system is well suited to mass greenhouse culture and automated intermediate transplanting.

Methods

In this greenhouse experiment, the growth of seedlings raised in Castle and Cooke CC-09 Mini-plugs (1 .3 cm diameter by 4.4 cm deep; 3834 cavities/M^2) and later transplanted into FH508 Japanese paperpots was compared with that of control seedlings grown from the beginning in FH508, FH408, and FH308 paperpots (respectively, 5.0 x 7.5 cm with 616 cavities/m2, 3.8 x 7.5 cm with 1066 cavities/m^2, and 3.0 x 7.5 cm with 1709 cavities/m^2).

Trays of paperpots (all three sizes) were filled with a 2:1 peat moss—vermiculite mixture; they were then sown with two seeds per paperpot cavity and covered with a thin layer of #10 silica grit. The Castle and Cooke Mini-plug trays were already filled with moist, cured growing medium (hereafter referred to as CC-09 plugs) when received from the manufacturer. Two seeds were sown per plug, and care was taken to place the seeds at the bottom of the sowing cavity. No seed cover was used. Sowing was completed on 8 February, and treatment trays were arranged in a randomized block design with four replications. The experimental unit was a single tray of containers or plugs (FH508 = 200 cavities, FH408 = 336 cavities, FH308 = 532 cavities, CC-09 = 400 cavities).

Germination in both paperpots and mini-plugs was completed in approximately 10 days. Seedlings were thinned to one per cavity on 28 February (20 days). As soon as the seedlings had reached the stage of primary needle initiation (11 days after germination), all treatments were placed on a constant fertilization program. A balanced water-soluble fertilizer (Plant Prod® 20-20-20) that contains micronutrients was used. Nutrients were applied initially at the rate of 50 ppm N; then the rate was increased to 100 ppm N after 2 weeks. Greenhouse temperatures ranged from 22 °C to 27 °C (72 °F to 81 °F), and daylength was extended to 18 hours with 1,000-watt G.E. Multi-Vapor H.I.D. lamps.

Eight weeks after germination, CC-09 plug seedlings were carefully dibbled into additional trays of FH508 paperpots filled with the same peat-vermiculite mixture used for the controls. After a thin layer of silica grit was applied, the trays of transplanted seedlings received an initial application of 300 ppm N of the same fertilizer to boost nutrient levels in the fresh peat; they were then re-randomized within the experiment. The experimental design included trays of non-transplanted CC-09 plugs. Subsequent tending and nutrition were the same for all treatments.

Seedling measurements began 2 weeks after germination and were repeated at 2-week intervals until the experiment was terminated at 14 weeks. Ten randomly selected seedlings per replicate were taken at each sampling date. Data were analyzed by two-way ANOVA for each sampling date; treatment means were separated by Tukey's multiple comparison test.

Results and Discussion

Growth progressions for shoot height and total seedling dry weight are illustrated in figure 1. In paperpots, each size of container produced a distinctly different growth curve. Although differences in shoot height were not significant (P = 0.05) on any sampling date, differences in total dry weight were highly significant (P = 0.01) at 12 and 14 weeks. The final mean dry weight of FH508 seedlings was 51 and 108% greater, respectively, than that of FH408 and FH308 seedlings. Final height-diameter ratios were also affected significantly, with the highest values in FH308 (11.8), followed by FH408 (10.0), and FH508 (8.9) seedlings. As a result of their closer spacing, FH308 paperpots produced seedlings with fewer side shoots and sparser foliage than did paperpots of other sizes (fig. 2).

In the CC-09 plugs, spacing and substrate volume restricted seedling growth from a very early age, and only small, slender seedlings resulted (fig. 2). The most dramatic effect was upon seedling dry weight (fig. 1). Although not evident visually, significant differences in dry weight were present as early as the first sampling date (2 weeks after germination), when seedlings had barely completed primary needle initiation. By the fourth week, CC-09 seedlings were only half the dry weight of FH308 seedlings; by 14 weeks, nontransplanted plug seedlings had only one-third the dry weight of FH308 seedlings.

Although the small size of the CC-09 plug was undoubtedly the principal restriction upon seedling growth, other factors may have contributed to the early stagnation observed. In comparison with the peat-vermiculite mixture used in the paperpots, Mini-plugs did not drain well after watering. Especially during the first 6 to 8 weeks, when seedlings were small and unable to take up the excess moisture, the plugs often remained saturated for extended periods after watering. This suggests that the oxygen supply to roots may have been inadequate at times, and may account for the significant depression in very early seedling dry weights. Later, plugs were also prone to excess salt accumulation. Because they did not drain well, it was difficult both to maintain a continuous flushing action through the substrate during normal fertilization, and to leach the substrate when soluble salt levels reached a critical level. Although there was no direct evidence to link these factors with the observed results, it remains possible that, by adversely affecting root health

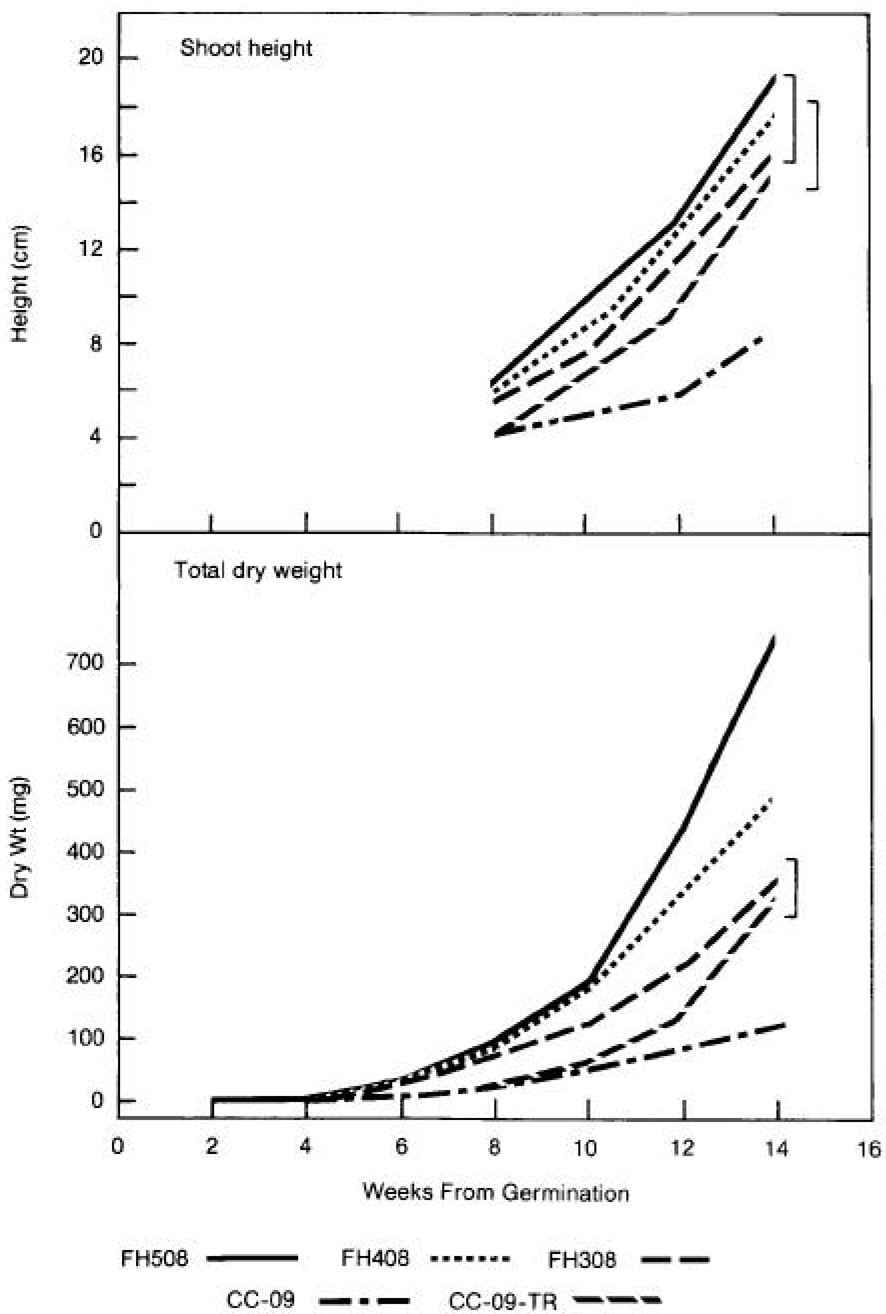

Figure 1—*Growth progressions for shoot height and total seedling dry weight. Bracketed means are not significantly different (P = 0.05) at 14 weeks (Tukey's multiple comparison test). (N = 40)*

and vigor, they might have weakened the ability of CC-09 plug seedlings to grow optimally after transplanting.

As it was, CC-09 plug seedlings responded quickly when transplanted into FH508 paperpots. Improvements in seedling color and increased shoot growth became evident within 1 week after transplanting. However, although shoot height increased rapidly, dry matter accumulation continued to lag until week 12 (fig. 1). Thereafter, transplanted seedlings (CC-09-T) grew rapidly and, by the time the experiment was terminated at 14 weeks, they had a mean dry weight nearly three times that of their nontransplanted counterparts. This resulted in seedlings not significantly different in size and weight from those grown in FH308 paperpots, although transplanted seedlings exhibited substantially better shoot form with more numerous side shoots (fig. 2). Nevertheless, transplanted seedlings were still 32 and 55% lighter, respectively, than seedlings grown continuously in FH408 and FH508 paperpots.

Because of the preliminary nature of this experiment, it was not continued beyond the greenhouse phase even though, in an operational setting, seedlings would normally be grown on outdoors to the end of the first or into the second growing season. The experiment showed that mini-plug seedlings can

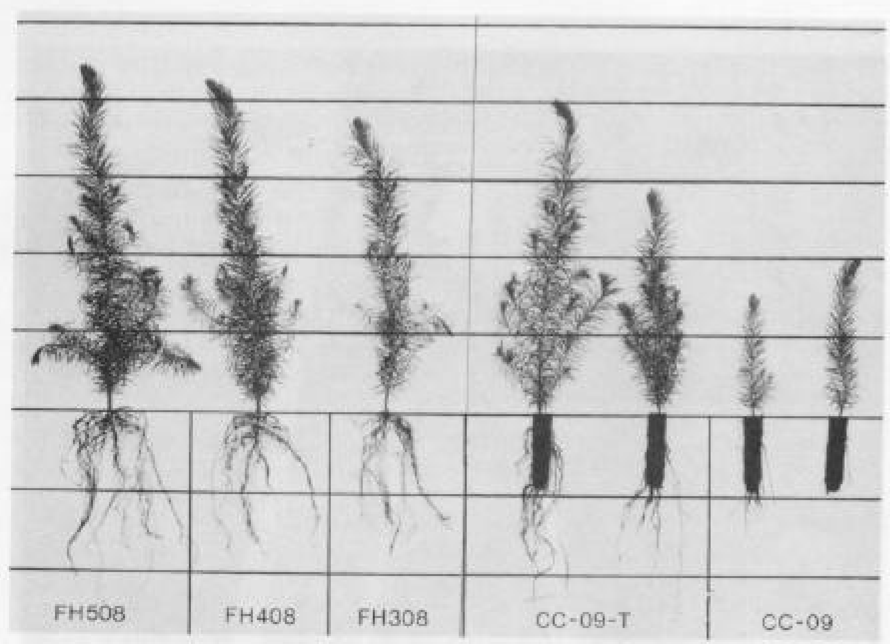

Figure 2—*Fourteen-week-old black spruce seedlings grown in three sizes of paperpot (FH508, FH408, FH308), as Mini-plug transplants into FH508 paperpots (CC–09–T), and continuously grown in Castle and Cooke Mini-plugs (CC–09). Horizontal line spacing is 5 cm.*

respond quickly after transplanting into larger containers, but perhaps not without penalty in comparison with conventionally grown container stock. The data indicate that intermediate transplanting produced seedlings with only 45% of the biomass of those grown from the beginning in the same size of final container (FH508). Although the gap might have been reduced if seedlings had been allowed to grow on outdoors, we have to question the acceptability of such a large reduction in growth potential.

It is possible that the cultural problems experienced with miniplugs, by causing an early check to seedling growth, may have exaggerated the difference between transplanted and nontransplanted seedlings. It is also possible that the transplanting date was inappropriate. Observations of seedling form and rooting habit suggested that black spruce seedlings should not be held in CC-09 plugs longer than about 8 weeks after germination before they are transplanted. Were these seedlings held too long? Would there have been less of a lag in dry matter accumulation if seedlings had been transplanted earlier? These are some of the biological questions that need to be addressed if mini-plugs are to be an acceptable vehicle for intermediate transplanting.