# Conical Container Improves Seedling Growth On Dry Sites

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*After several years of monitoring performance of container grown seedlings, the Canadian Forestry Service found that the tube technique developed in Ontario, while practical, yielded unsatisfactory performance. So they tested a conical shaped container to see whether performance could be improved. The conical container produced seedlings markedly superior in growth rate.*

Container grown seedlings have been planted on an increasingly large scale in Alberta since 1962, and current use by the Provincial Forest Service and industry is about 3 million seedlings yearly. Design and practice have in general followed the techniques developed in Ontario (3) of using a 3/4-inch by 3 1/4-inch rolled tube of high impact polystyrene containing an 8 to 12 week old seedling grown in peat (2).

The Canadian Forestry Service has done much experimental work in monitoring the survival and growth of seedlings of this type in comparison with other container seedlings. 2 by 1968, the practicability of a container system of planting had been demonstrated, but the performance of seedlings planted in a 3/4-inch tube was not satisfactory. So work was initiated to test a wider range of container seedling types, mainly to determine whether a different design of container giving greater root freedom and using larger plants could improve survival and initial growth.

Success in planting container seedlings, particularly on dry sites, depends upon rapid establishment of the roots in the surrounding soil. While this is taking place, moisture conservation in the container is necessary to protect the seedling against drought. Field observations on open ended cylindrical containers suggested that the vertical walls did not encourage or guide the lengthening roots into the surrounding soil, and we thought that an inverted conical shape might be more effective. Furthermore, considering moisture conservation in the container, the small top area of a 3/-inch tube intercepts little rainfall while the contained rooting medium is effectively insulated from the surrounding soil moisture.

(Containers dry out in the field even when the surrounding soil is relatively moist.) As the container seedling grows, it deflects or intercepts a portion of the incident rain. We thought that a wider mouth on the container, ideally funnel shaped, would intercept more moisture and direct it into the container. A combination of these ideas produced another, namely, the insertion of one cone into another to cover a large part of the surface of the rooting medium thus reducing surface evaporation.

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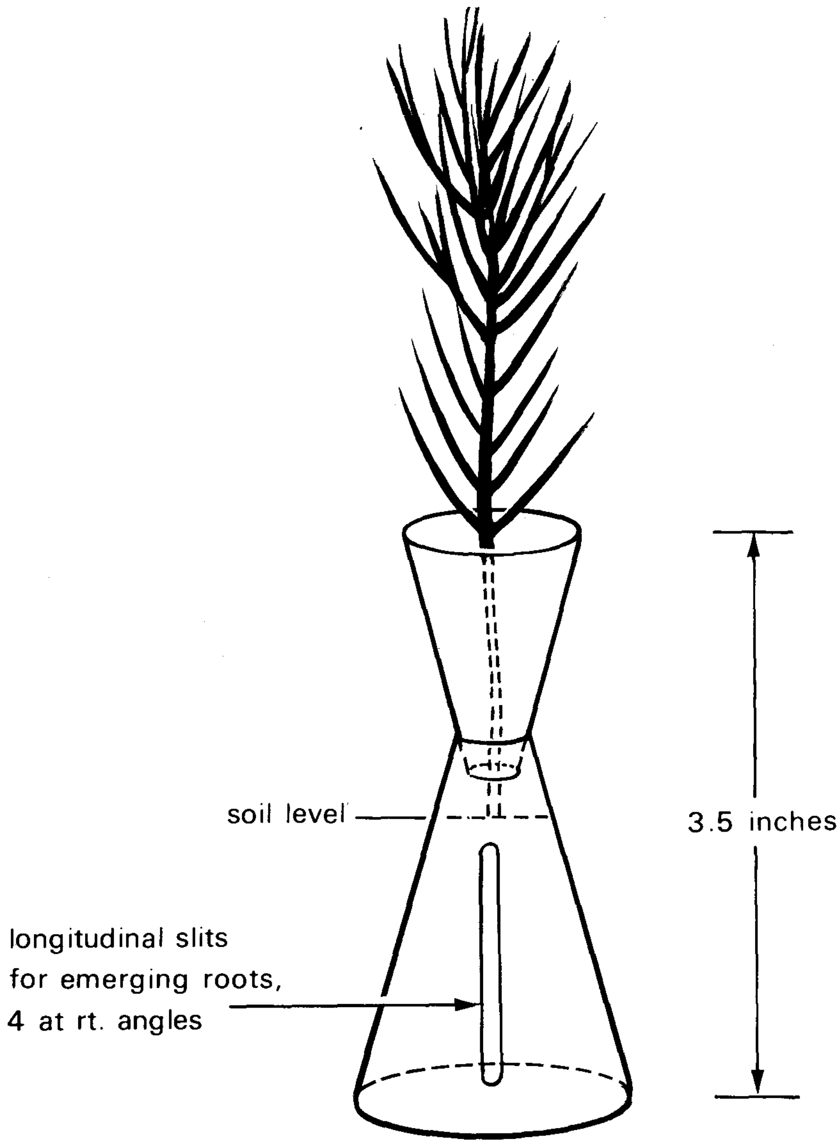



Figure 1.-Conical container

The conical container thus produced (fig. 1) was field and greenhouse tested in 1968 to determine the validity of the design concepts.

## Methods

Forty containers were made by hand from soft, black, polyethylene sheeting secured with tape and fused together with a hot iron. Black containers are less conspicuous to birds and raise temperatures in the contained soil (cold soils are common early in the growing season in Alberta). Four longitudinal slits were made in the sides of the base cone to allow roots to emerge. The lower cones were filled with soaked, sieved peat, up to the point of the top cone. Seeds of lodgepole pine *(Pinus contorta* Dougl. var. *latifolia* Engelm.) were pregerminated to obtain more uniform seedling size, and sown into the container by dropping them down the top cone and covering them with a thin layer of leached no. 2 granite grit. The seedlings were raised in a greenhouse with a day temperature of 70°F. and a night temperature of 50°F., a 16hour photoperiod, adequate irrigation, and a weekly application of Ingestad's (1) nutrient solution. Two weeks before planting, the seedlings were placed in cold frames to harden off.

Seedlings of two ages (64 days and 81 days) were planted at the same time. Half were planted in the field (randomized block design, three blocks) and half into soil monoliths in the greenhouse (randomized block design, four blocks). Those in the greenhouse were for measurement of growth under optimum conditions for advance information on performance. The conical container was set out so that the peat surface inside the lower cone was on a level with the surrounding soil, leaving the upper cone above ground level.

In both greenhouse and field plantings, 107-day-old seedlings of lodgepole pine in 3/4- by 3 1/4-inch polystyrene tubes (the current operational container) seeded with pregerminated seed and grown in the same environment were planted with the conical containers for comparison. No initial weights are available but growth was significantly better in the conical containers by the end of the rearing period. This is ascribed to the larger rooting volume provided by the conical container; 2.24 cubic inches as opposed to 1.48 cubic inches in the 3/4 inch cylinder, which, based on related work, we know could increase total plant weight by 92 percent.

The field plantings were established in Kananaskis Research Forest, Alberta, (altitude 4,500 feet, latitude 51' North, longitude 115° West) on an old river terrace with 2 feet of freely drained, fine loamy sand overlying mixed rock and gravel. Average annual precipitation at the planting site is 27 inches, of which 10 inches is snow. (Precipitation from May to August in 1969 and 1970 was 13.2 inches and 8.9 inches.)

## Results

### *Greenhouse Trial*

Seedlings planted into monoliths in the greenhouse were excavated after 11 weeks and the dry weight of roots and shoots were determined. Figures 2 and 3 show seedlings in the two container types after excavation. Those in the conical containers are 26 days younger, but the data in Table 1 show that they are significantly larger and have grown more and longer roots in the surrounding soil.

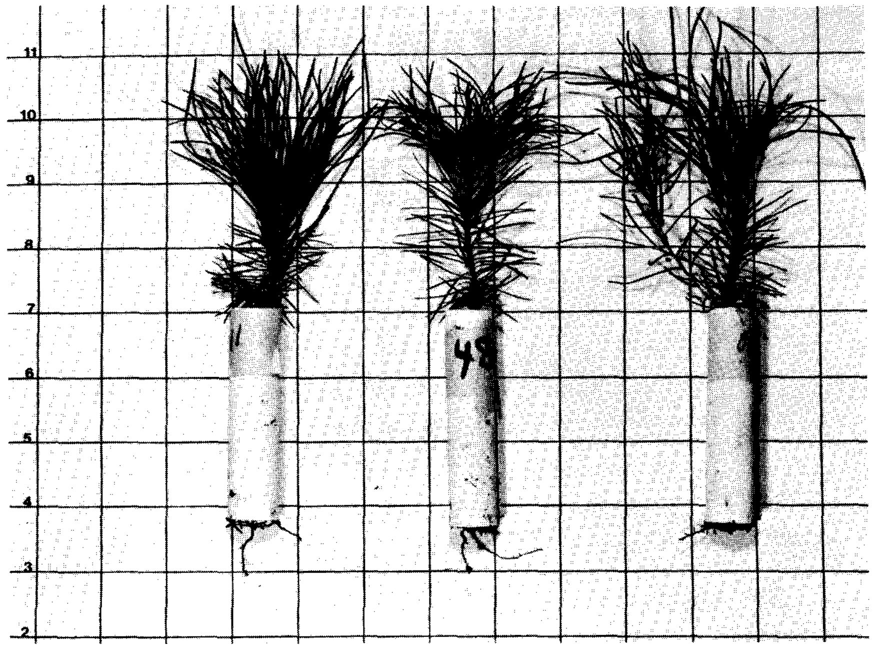
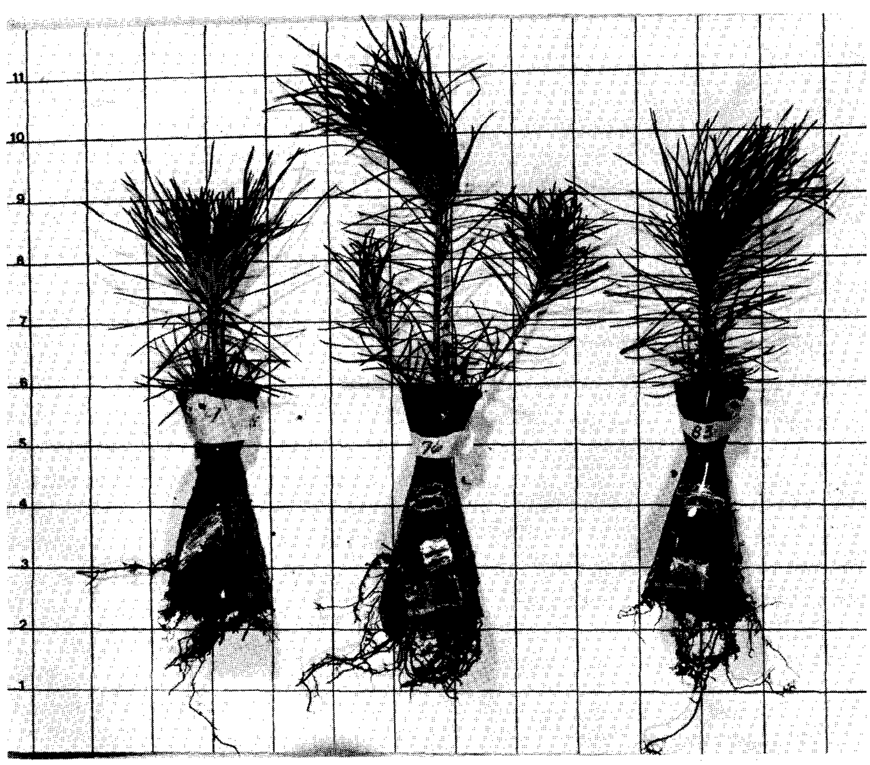



Figure 3.—Seedlings in cylindrical containers after excavation from greenhouse.

The seedlings in the conical containers were three times the weight of

Figure 2.—Seedlings in conical containers after excavation from greenhouse.




those in the cylinders despite being younger at time of planting. The former had significantly larger shoots and roots and three times the proportion of their root system outside the container. There was no significant difference in the final sizes of the two ages of seedlings in the conical containers.

### *Field Trial*

Seedlings in the field trials were excavated in October 1970, 2 years after planting. (Figure 4 shows excavated seedlings in conical containers.)

Final dry weights of the field-planted seedlings after excavation are shown in Table 2.

Growth of the 81-day-old seedlings in the conical containers in the field was significantly greater in top and root than that of the seedlings in the 3/4 inch cylinders. The former had produced a much larger root system and a much larger proportion of this was outside the container. Contrary to greenhouse results, the 64-day-old seedlings in the conical containers had not

TABLE 1.—*Oven dry weights of seedlings planted in conical and cylindrical containers after 77 days in the greenhouse*

| Container type | Age at excavation (days) | No. of observations | Mean dry weight (mgs) | | | Roots outside container as percent of total | Mean shoot/root ratio |
|---|---|---|---|---|---|---|---|
| | | | Roots outside container | roots Total | Total weight plant | | |
| Conical | 141 | 7 | 171 | 492 | 1945 | 35 | 2.9 |
| | 158 | 13 | 158 | 535 | 2040 | 30 | 2.8 |
| Cylindrical | 184 | 17 | 20 | 236 | 667 | 8 | 1.8 |

funnel shaped wider mouth to intercept and direct rain into the container. While the conical container tested may have handling disadvantages which [may] detract from its operational use, some of these can be eliminated by changes in design without affecting the underlying principles, while others may be acceptable because of the excellent growth obtained.

grown as well as the 81-day-olds and there were no significant differences between these and the seedlings in the 3/4-inch cylinders.

## Conclusions

The marked superiority of growth in the conical container confirms the validity of some of the observations that prompted its design, namely, increased rooting volume, guidance of roots out of the container by wall taper and better moisture conservation by a

TABLE 2.—*Field survival and oven dry weights of 2 year old seedlings—field planted in conical and cylindrical containers.*

| Container type and age at planting | Number planted | Survival | Mean dry weights | | | Roots outside as percentage of total roots | Mean shoot/root ratio |
|---|---|---|---|---|---|---|---|
| | | | Roots outside container | Total roots | Total plant weight | | |
| | | *Percent* | | *mgs* | | *Percent* | |
| Conical 64 days | 7 | 86 | 46 | 162 | 547 | 28 | 2.4 |
| Conical 81 days | 13 | 92 | 140 | 383 | 1437 | 37 | 2.7 |
| Cylindrical 107 days | 59 | 90 | 11 | 116 | 300 | 10 | 1.6 |