

Plug + One Production of Colorado Blue Spruce at The Colorado State Forest Service Nursery¹

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Plug + One (P+1) refers to a unique production method for many Great Plains conservation nurseries. The method was originally developed in Oregon in 1971. It is now a common method for reforestation nurseries in the northwest (Hahn, 1984).

It is a combination of two growing environments - the greenhouse and the bareroot field. The term plug refers to the greenhouse-grown container seedling. Container sizes can range from miniplugs-only one cubic inch in size-to ten cubic inch cells. Containers are then transplanted to the fields in spring, late-summer or fall for an additional growing season in outdoor transplant beds.

In only two growing seasons a large caliper, bushy topped and heavily rooted seedling is produced, equivalent in size to that of the more traditional 2+2 or 2+1 transplant. The mop-like appearance of the root system is the most unique feature in comparison.

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Abstract – Plug+ 1 refers to a combination of two growing environments. A small greenhouse grown plug is produced then transplanted into outdoor beds. Article outlines greenhouse and field production methods followed at the Colorado State Forest Service Nursery for Colorado blue spruce (*Picea pungens* Engelm.).

PRODUCTION METHOD

Container Phase

Originally, the Colorado State Forest Service Nursery (CSFS) began P+1 production using a large ten cubic inch container – the "Ray Leach Super Cell." Demand for the seedlings and limited greenhouse production space led to using the smaller four cubic inch "Ray Leach Pine Cell." This change doubled greenhouse production capacity.

Seed is sown in late August and the crop actively grown until January. Growing conditions are described in Table 1.

With most of the growing and hardening occurring during fall and winter, stagnant air develops due to minimal air circulation. Grey mold (*Botrytis cinerea*) is a serious problem that is controlled by preventive applications of fungicide on a bi-weekly basis.

Table 1.—Greenhouse Growing Conditions at CSFS Nursery.

Day Temp	70-75°F
Night Temp	70-75°F
Supplemental Lighting	All-night Intermittent
CO ₂	700-800 ppm
Fertilizer	N = 100 ppm P = 50 ppm K = 74 ppm + micros
Mycorrhizae	<i>Rhizopogon</i> spp.

Stock hardening is begun in January. Supplemental lighting is turned off, nitrogen levels reduced to 60 ppm and temperatures are gradually reduced to near outdoor ambient conditions. By late March the stock is ready for transplanting.

Transplanting

Due to work load impacts from the seedling distribution season and other production priorities, the stock is held in the shade house until mid-August when it is transplanted to the field (Figure 1).

A spring flush is experienced in the shade house but continued growth is not actively encouraged. Stock is watered and fertilized on an as needed basis using the 60 ppm nitrogen solution.

Transplant beds are prepared and phosphate fertilizer, 0-46-0, applied prior to planting. Goal 1.6E herbicide is applied for weed control. A twin row tree planter is used for transplanting. Two passes are required to make up the four row beds. Transplant density is approximately four seedlings per linear foot.

After planting transplant fields are watered heavily to minimize transplant shock and provide cooling. As summer temperatures moderate irrigation is reduced to maintain bud dormancy and prepare for winter.

By early December, time of soil freeze up, four to six inches of new root growth has occurred. The seedlings are well established in the beds and no frost-heave problems are experienced over-winter.

Field Growing

Beginning in late April ammonium sulfate (21-0-0) is applied bi-weekly at a rate of 200 pounds product per acre totalling about 700 pounds in a season. Fertilization ceases around mid-July.

Colorado's arid climate means no disease problems are experienced during the second growing season. Fusarium root rot, a common disease with many Great Plains nurseries, is not a problem here yet. The CSFS Nursery has never used soil fumigants for disease or weed control.

Rare occurrences of Douglas-fir tussock moth have been noted in nursery windbreaks but insect populations have never reached problem levels. Climatic conditions mean no top mowing is necessary and no root pruning or wrenching is done. Stock is ready for harvesting in mid-November.

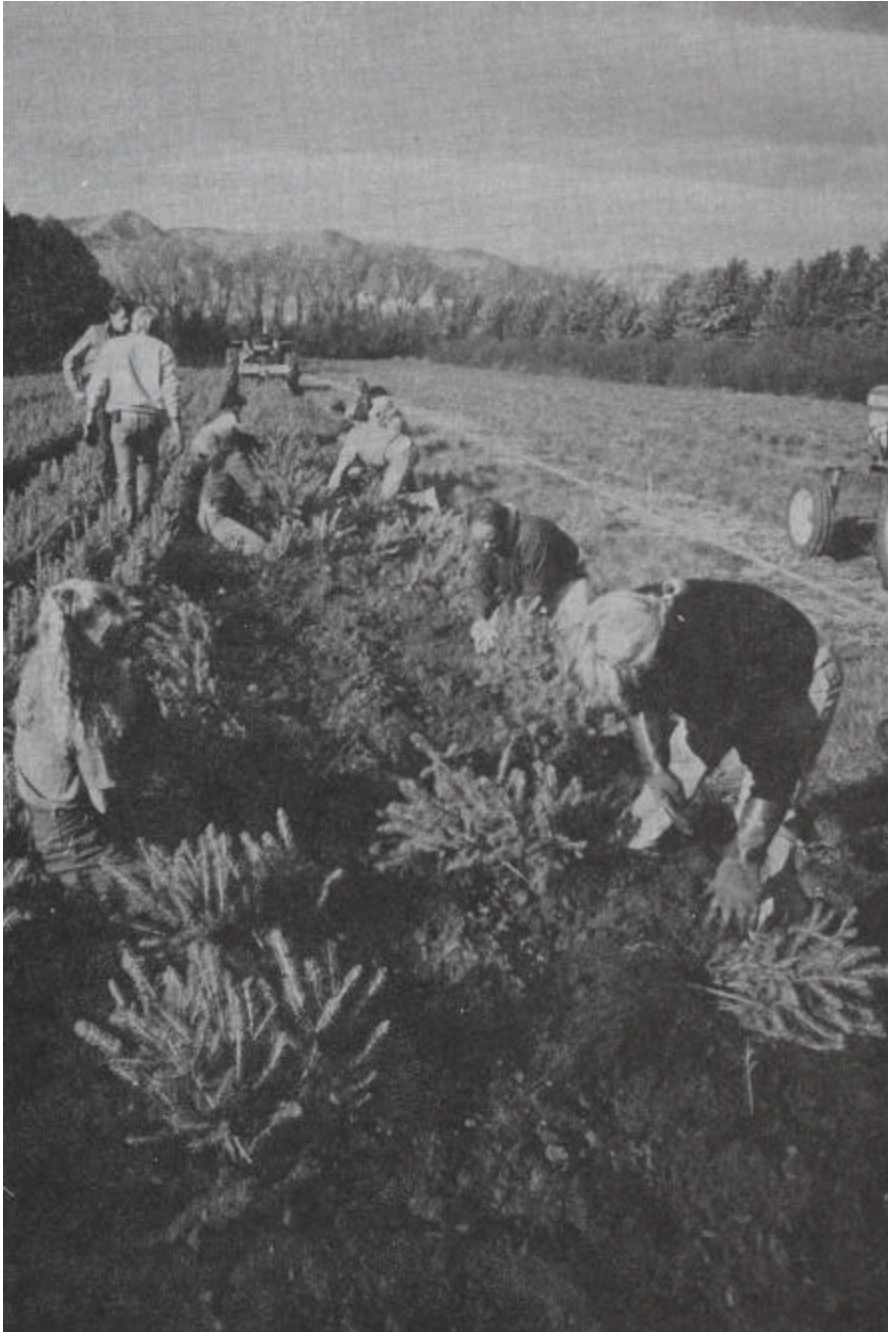


Figure 1 – Lifting P+1 Transplants of Colorado blue spruce

DISCUSSION

Container size greatly impacts finished seedling size at the CSFS Nursery. The ten cubic inch containers produced a seedling 14" to 18" tall with 1/2" caliper. Changing to the four cubic inch container reduced height to six or eight inches with 1/4" caliper. Outplanting results and popularity with customers have remained the same despite the change.

Other Great Plains conservation nurseries are experimenting with much smaller two cubic inch containers. Results so far indicate two growing seasons outdoors may be required to attain a size similar to 2+1 or 2+2 transplants commonly available in the region.

The P+1 method seems to provide the best of both worlds - the superior fibrous root systems from container growing and the hardy foliage from the outdoors.

REFERENCES

Hahn, P. F., Forest Nursery Manual, 1984, Duryea, Mary L., and Thomas D. Landis (eds.).