

Cultural Perspectives

The "Nursery Effect"

$$\textit{Phenotype} = \textit{Genotype} \times \textit{Environment}$$

This equation is the mathematical expression of the fact that an individual's appearance is the result of its genetic make-up, tempered by the environment in which it was raised. In the forest and conservation nursery business, the physical characteristics of a seedling are a function of its genotype, generally expressed as seed source, and the environment of the nursery in which it was grown. Actually, nursery environment is a composite of the location of the nursery and the cultural practices used to raise the seedling. Incorporating this information into our equation produces:

$$\textit{Seedling Morphology} = \textit{Seed Source} \times [\textit{Nursery Location} \times \textit{Cultural Practices}]$$

In bareroot nurseries, seedlings are grown under ambient climatic conditions and so become naturally acclimatized to the nursery environment. Because bareroot stock is acclimatized to the general climatic of a geographic region, they are not normally shipped outside that region. With the advent of container nurseries, however, it has become possible to grow seedlings in one geographic region and ship them to another. Theoretically, as long as the seed source is carefully selected and maintained during the nursery tenure, a container seedling can be grown almost anywhere as long as it is properly hardened prior to storage and shipment to the outplanting site. Seedling users need to know the biological implications of this practice to insure that they are receiving the highest quality stock for their reforestation projects.

This concept has immediate practical implications because container nurseries are beginning to expand their markets and bid on seedling growing contracts from vastly different environments. In recent years, for example, a container seedling grower in Colorado has produced tree seedlings for a timber company in British Columbia. Another contractor in Northern California has grown conifer stock for outplanting in New Mexico. Because of a tremendous reforestation backlog in Mexico and a shortage of local nursery stock, some people are advocating growing container seedlings of Mexican species in the US or Canada.

I hypothesize that seedlings of the same seed source grown in nurseries with significantly different environments will respond differently upon outplanting. This response has been called the nursery effect and is an example of environmental imprinting in which the seedlings "remember" the influence of nursery site conditions or cultural practices. Apparently, these "memories" can override normal genetic controls, at least temporarily.

Forest geneticists have written extensively about genotype X environment interactions and how they influence early genetic selection, but the nursery effect is not widely appreciated in the nursery community. However, nursery imprinting is evident in day-to-day nursery and reforestation activities. Foresters who have planted seedlings from the same seed source that were grown at different nurseries have noticed differences in survival and growth. Bareroot nurseries who transplant container or bareroot seedlings from other nurseries have observed similar differences. I remember one nursery trial that I established with fall-sown vs. spring-sown bareroot seedlings of the same source sown right next to one another. The fall-sown stock was of course larger at the end of the first year because it had germinated earlier. What surprised me was

that the fall-sown seedlings also broke bud significantly earlier the following year, showing that it had been imprinted with its response from the 1+p year.

The nursery effect is extremely hard to prove by experiment, however, because of the complexities in raising seedlings of exactly the same size, the larger sample sizes that would be necessary, and the problems in holding all other variables constant. Some formal experiments have shown that the nursery effect does exist and can be quantified in terms of seedling performance on the outplanting site. Ying and others (1989) concluded that, although the differences between nurseries were significant, the nursery effect is relatively shortterm (15 years). Another study in Alaska compared container seedlings from a local nursery vs. ones grown from the same seed source in Idaho (Zasada and others 1990). The Idaho trees suffered significantly more animal browsing and frost damage compared to the local stock. I am not aware of other research trials, however, probably because the nursery effect on seedling survival and outplanting is often hard to separate from the other stresses and complicating factors.

The nursery effect has some practical and economical implications, especially with seedling growing contracts:

*** Should local growing zones be established?** If so, who is going to do it and how large should they be?

*** Should nurseries be rated by past performance?** How can you separate true environmental imprinting from just poor culture or fluke weather events?

*** What about species differences?** Is the response the same with all species?

Well, there you have it. Is the nursery effect a legitimate concern or merely the product of another government bureaucrat with an overactive

imagination and too much time on his hands? After all, ornamental nurseries have been growing their stock in nurseries in just a few selected geographical areas, including the Pacific Northwest, and then shipping them across the continent using only the Plant Hardiness Zones as their guide. Anyway, I'd like to hear from you and, if there is enough interest, I'll provide some follow-up in the next issue of FNN.

Source: Ying, C.C.; Thompson, C.; Herring, L. 1989. Geographic variation, nursery effect, and early selection in lodgepole pine. *Canadian Journal of Forest Research* 19(7): 832-841.

Campbell, R.K.; Sorensen, F.C. 1984. Genetic implications of nursery practices. IN: Duryea, M.L.; Landis, T.D. eds. *Forest Nursery Manual: Production of Bareroot Seedlings*: 183-191.

Zasada, J.C., Owston, P.W.; Murphy, D. 1990. Field performance in Southeast Alaska of Sitka spruce seedlings produced at two nurseries. *Research Note PNW-RN-494*. Corvallis, OR: USDA Forest Service, Pacific Northwest Research Station. 11 p.