XI. James M. Trappe, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Substituting for William Stein. Subject: Seedling Biographies - Keys to Rational Nursery Practices.

SEEDLING BIOGRAPHIES--KEYS TO RATIONAL NURSERY PRACTICE

by
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When a nursery bed is not producing the kind of seedlings desired or when planters complain about the kind of stock they are getting, the nurseryman must dip into his bag of tricks to solve the problem. He can change fertilizing, irrigating, root pruning, and a host of other practices. Too often, however, he must swallow a bitter pill of frustration--neither he nor anyone else knows enough about the growth habits and abilities of the seedlings to prescribe a remedy on the basis of logic rather than trial and error.

Detailed records of seedling life histories--seedling biographies--are fundamental to rational nursery practice and operational management. Once the nurseryman has biographies of the species he raises, his basis for prescribing suitable practices is greatly strengthened. He can more logically predict how a chosen practice may affect growth and form of each species. He has a sound biological basis for timing operations.

A variety of information can contribute to a seedling biography, but phenological facts are essential. When do roots and tops grow most actively, and when are they dormant? How does root growth correlate with top growth? How do roots respond to pruning or tops to mowing, and how does response vary with season? When do mycorrhizae form and what is their abundance? How do food reserves and nutrient contents vary during the course of a year?

Stating that such information is desirable is like supporting mother and country, but how many nurseries have it available for each important species they grow? Experienced nurserymen have stored up much useful information. But unless data on seedlings have been systematically gathered and recorded for future use, biographies will inevitably be fragmentary and unsuitable for use by the less experienced.

By systematic gathering of data, we mean planned sampling at chosen intervals, objective measurement of seedling attributes, and careful recording. In any study planned, sampling should be random and replicated. Let's not be overawed by statistical terms-- randomization and replication simply increase your information. They insure that your observations are unbiased and represent more than just quirks of a single seedling or patch of seedbed. Adequate sampling is needed whether or not statistical analyses are planned.

Phenological data can be graphed to detect seasonal trends and relationships, e.g., relationship of shoot growth to root growth and of both to weather. Effects of fertilizer, chemicals, root pruning, etc., can be compared to untreated parts of beds by similar sampling and measuring methods.

One of our studies at Wind River Nursery, though more complex than advocated for widespread use, illustrates how information on seedling biographies can be put to work. Every 2 weeks for 14 months, we lifted three randomly located samples from one bed each of coastal and interior Douglas fir. We observed proportion of actively growing root tips for different parts of the root system, swelling and bursting of buds, length of growing shoot, and stem diameter. Subsamples from each 2-week lifting were analyzed for food reserves.

Our data have not yet been fully evaluated, but preliminary examination has yielded interesting leads. For example, root growth of both seed sources peaked in the month preceding bud burst. As buds began to swell, root activity rapidly diminished, hitting a low point soon after bud burst. Root growth remained minimal during the period of rapid shoot growth, then gradually increased to another peak in August. The tentative moral of this very simple kind of observation is that once buds begin to swell, the planter had better not expect much root initiation or elongation until late summer. Implications of these root growth patterns for scheduling lifting and planting operations in regions of summer drought are rather obvious.

Phenological events correlated with information on seedling carbohydrate levels can yield some highly interesting leads for the nurseryman. At Wind River, root carbohydrates dropped to a low level twice during summer. The first was a 2-week period in late June, followed by a build-up in carbohydrates that in turn was followed by the August burst of root activity. The second low period for root carbohydrates came in early September on the heels of August root growth. As top growth stopped in September, roots again began to accumulate carbohydrates.

How might the nurseryman use this information? Carbohydrates are the stored energy of seedlings. It makes biological sense to prune roots at their ebb of carbohydrate content to minimize loss of this stored energy. For stock scheduled to be lifted in the fall at Wind River, then, late-June pruning would be timed close to low root carbohydrate content followed by carbohydrate build-up and the August flush of new root initiation and growth. Seedlings to be lifted in spring, on the other hand, might be pruned in the September low period when shoots are becoming dormant. Carbohydrates would subsequently build up to their yearly maximum during winter. This energy would then be available for the spring surge of root growth. Moreover, because root growth in winter months is slow, September-pruned stock would push down relatively few deep roots to be lost at lifting time.

We should add at this point that the whole seedling is affected by root pruning, and as yet we have not tested effects of different pruning schedules on seedlings. But now we have an informed basis for doing so.

Similar information on carbohydrates and their relation to growth can be used for lifting schedules. For example, seedlings to be held in storage over winter should be lifted as late as possible. When shoots finished growing at Wind River in late summer, seedling carbohydrates were comparatively low. Supplies were gradually renewed from late October through mid-January, when the yearly peak was reached and maintained until spring root growth started. The closer to January seedlings can be lifted, the more energy reserves they have to carry through storage. Similarly, spring lifting before active root growth would catch seedlings at maximum levels of stored energy which they then can use to produce roots at the planting site.

How does root pruning affect different species or sources? Our experiments showed that coastal Douglas fir reacted quite differently than interior Douglas fir. After pruning, coastal Douglas fir initiated relatively few new roots. Rather, the remaining smaller laterals grew more actively, resulting in a bushier root system. Seedlings of interior Douglas fir, in contrast, initiated numerous new roots above the pruning wounds. Newly initiated roots grew down into the same areas previously occupied by roots removed in pruning. The residual root system showed little response. A noticeably bushier root system was not developed by this source of interior Douglas fir.

A wealth of other information can be developed by similar, simple, systematic observations for each of the species grown in a nursery. Keep in mind that while seedlings' normal habits provide the most logical basis for predicting their response to a practice, one cannot assume that the prediction will always be correct. Unobserved factors play their role, too. For example, pruning or mowing can disrupt a seedling's "signal system" of growth regulators. Therefore, any change of practice based on better knowledge of seedling growth characteristics should first be tried on a limited scale with adequate control plots for comparison. Well-designed outplanting tests may often be required for final evaluation of contemplated practices.

Many of you are doubtless thinking that development of seedling biographies sounds like full-time research. In a sense this is true; yet you nurserymen are already continually observing the development of seedlings. A Ph.D. is not needed to systematize and supplement these observations. To do it well--i.e., systematically with complete recording and careful interpretation of information over a period of years--would certainly require a well-trained, keenly observant professional. But once a basic scheme of systematic observation is devised, it can be applied to all species and sources. Chemical analyses, when desired, can usually be contracted out to State agricultural experiment stations. All of you have research groups available to help you design and interpret such practical studies.

In summary, we reemphasize that seedling biographies provide the best initial basis for defining nursery practice. This basic knowledge, if systematically collected and recorded, supplies the leads for building the kind of seedling that you want. Too often we do things out of habit or for convenience -- these are not sound bases for nursery practice. If better knowledge forces a change from a convenient practice to one less convenient, then all right--you are ingenious enough to adapt operations to produce the best possible planting stock.

XII. C. J. Eden, California Department of Conservation. Subject: Use of X-Ray Techniques for Determining Sound Seed.

1. Mr. Eden was asked to give the specifications for the exposure and force radiation rates that they use.

   Average: 13 kilo amps, 10 mileamps, 16 seconds.

   Douglas fir rates: 12-10-18, 12-10-14

2. He was asked by Mr. Evans what he hoped to accomplish with this procedure. He explained that it was to arrive at a germination date without 4 months stratification and another month of long germination tests. With this procedure it is only a matter of a day or so.

3. Mr. Eden was also asked to give other advantages of this procedure. He answered that it shows up the obviously bad seeds such as those destroyed by insects and disease; you can see which seeds had actually deteriorated during germination and it is a good potential for determining what percentage of your seed is bad. It also shows up cracks, and you can run controls on various equipment to see if it is damaging the seed.