How to Use Seedling Quality Measurement in Container Nurseries[1]

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Abstract--The various techniques for measuring seedling quality are discussed in relation to the time of testing. How the data thus gathered can be applied to cultural practice alternatives is also discussed with a common sense approach to growing seedlings.

There is a wide range of seedling quality tests available and these have been discussed quite adequately elsewhere (Burdett 1983, Chavasse 1980, Ritchie 1984). The procedures for these tests are covered in Ken Munson's paper (pp 71-77).

The purpose of this paper is to discuss how to use the data gained from these tests over the life of a crop to produce a better seedling.

MEASURES MADE DURING THE GROWING SEASON

Morphological measurements which consist of height, caliper, shoot and root dry weights and-late in the season--bud heights can generate growth curves over time and provide an indicator of how well your crop is doing in meeting size specifications required by your customers. Water and nutrient regimes can be used to increase or decrease growth as needed during the growing season. You need to keep in mind time and climate constraints. The unwise practice of extending the active growth of seedlings into the late fall and early winter could have some disastrous effects on your crop. Top growth must cease early enough to allow bud development in later summer. Good bud development requires short days and warm temperatures. If active top growth is continued into September, there will not be enough warm temperatures to ensure proper bud development after the cessation of growth. Root development also takes place in the fall and again, if top growth is extended, the gains in seedling height will be made at the expense of root development. Root dry weights can continue to increase through October and if the height growth has ceased in August, good root mass is the result.

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Very little has been written on minimum specifications for root mass and bud size, but experience and common sense can give some indication of where to start. Root dry weights of .40 grams in Douglas fir grown in a 2.0 cubic centimeter container are adequate or better. This root mass will hold its configuration when extracted and provide adequate or better root growth capacities when there are no physiological problems present such as disease. Root dry weights of .30 grams or less usually do not maintain their integrity and generally have lower root growth capacities. Seedlings with finer root systems such as spruce, hemlock and cedar have an adequate root mass at .30 grams. Bud heights in Douglas fir are adequate at 4.0 centimeters. This is measured from the base of the bud where the bud scales begin to the top of the bud. Buds less than four centimeters tall tend to be poorly developed and are usually less frost-hardy than larger buds. Bud heights indicate growth potential for the following year and thus are very important to your customers.

Determining the nutrient levels of tissue is a very important tool for the container grower. The opportunity is there to get rapid results by altering the nutrient regime according to seedling needs for either more or less growth. Each grower needs to establish a nutrient regime suitable for his particular species, the geographical origin of stock, the container sizes and the geographical location of his facility. All of these things will affect the growth of the crop. It is best to use a reputable lab which will provide the expertise in interpreting the nutritional data in the beginning. Later, after the grower has gained some experience with his particular situation, he can prepare his own fertilizer prescriptions. One caution to remember in designing nutrient regimes is that what may work for one grower with his unique combination of species, stock types and geographical location may not work for another.

Most growers use some form of moisture stress treatment to induce dormancy at the end of the growing season. The most common method of measuring plant moisture stress (PMS) is the pressure chamber method (Cleary and Zaerr 1980; Ritchey and Hinckley 1975). On the other hand, high levels of PMS during the growing season will reduce seedling size. The pressure bomb can be used to keep PMS levels low during the period of active growth and then keep the PMS levels high enough to induce dormancy, but not so high that damage is done to the seedlings. Many growers rely on block weights to determine the need for irrigation both during active growth and the hardening-off phase. This method requires considerable experience in determining how to irrigate by the weight of various-sized blocks. Block weights can vary depending on the consistency of the media, size of seedlings and several other factors. The PMS measurements are a more direct measurement of the moisture status of the seedlings.

MEASURES MADE PRIOR TO LIFTING

This is the time when the finished product is checked for overall quality to ensure that the seedlings are ready for the stresses of storage and outplanting and thus have a good chance of surviving in the field.

Morphological characteristics are the most commonly used measures of seedling quality employed at the time of packing. Almost all seedlings must meet predetermined height and caliper standards to be considered saleable. Although these attributes have failed to predict field survival in the past as accurately as we need, they are still important, and we need to continue to use these attributes as a measure of seedling quality. In order to better predict successful plantation establishment, we need to add more morphological attributes as well as some physiological attributes that are to be discussed later. The morphological attributes we need to add to our specifications are bud height and root dry weight. These two attributes will ensure we have good enough bud and root development to ensure good growth and survival in the field, which are critical for good plantation establishment. There are other methods for measuring these attributes and these are discussed in Dave Simpson's paper (pp 78-83). The bud heights and root dry weights, however, are the simplest methods being used operationally at this time. These are also specifications that can be given a number and written into the seedling growing contract.

There are various methods of determining the best time to lift seedlings for storage (lifting window) and again, Dave Simpson has discussed these methods more fully. Cold-hardiness is being used operationally for this in a number of areas and is a relatively rapid way to determine readiness for storage (Burdett and Simpson 1984; Glerum 1985). Lifting windows may vary with seed source, species, yearly climate fluctuations and cultural practice regimes. This is, again, a situation where each grower needs to become fa-iliar with how his unique situation affects the lifting window for his stock.

Cold-hardiness levels may also be needed to ensure survival in the field when below freezing temperatures are expected shortly after planting, particularly in the case of fall planting. The situation often arises when seedlings are being grown a considerable distance from the seed origin. For instance, Intermountain seed sources are being grown in the Pacific Northwest. In this case, the frost hardiness development of the seedlings whose origins are in Idaho, but who are hardened off in Oregon will be less than if the seedlings were hardened off in Idaho (Unpublished data, Johnson, 1985). This can cause losses due to cold damage in the field. It is wise to keep this in mind when growing seedlings not from your own seed zone.

MEASURES PRIOR TO PLANTING

Assuming that all seedlings have already been graded for morphological attributes, we now need to determine the physiological state of the seedlings prior to outplanting. Overwinter storage of seedlings can either be in a controlled cooler or freezer or, in many cases, be uncontrolled outside storage. The controlled units are, of course, preferable, as uncontrolled storage usually depends on a snowfall prior to the onset of very cold temperatures to protect seedlings from cold damage. As everyone knows, some years you get the snow and some years you don't. Even controlled storage units can malfunction, allowing the seedlings to experience damaging temperatures. To ensure that no deterioration of stock quality has taken place during the period of storage, a root growth capacity test is in order. Most operational root growth tests available take place in a controlled environment at relatively warm temperatures with an extended photoperiod. The duration of the test is approximately thirty days. Interpreting root growth data is in the initial stages in many areas of the western United States, but we do have enough experience to give some helpful hints for interpreting the test results. Root growth capacity values that may prove satisfactory in Western Washington may not be satisfactory in Colorado. The severity of the planting site will determine what root growth capacity is adequate. Seedlings that produce any new roots at all in the thirty day period have a chance of surviving, given the right conditions. However, seedlings that produce fewer than 30 new roots over one centimeter in length during the test have a poor chance of survival on the dry sites of the San Juan National Forest (Unpublished data, Johnson 1985). The seedlings producing fewer than 11 new roots over one centimeter have a poor chance of survival in the better sites of the Olympic National Forest in Washington (Unpublished data, Johnson 1985). Experience has also shown that seedlings that fail to produce over 30 new roots over one centimeter during the test usually have something wrong with them. The problem may be inadequate root mass, damaged roots or dead roots due to disease, overwatering, etc. One- to two-year old seedlings of most, if not all, species of conifers are capable of producing over 50 new roots over one centimeter in length within the 30-day test with a fairly high rate of frequency; therefore, expecting a minimum of 30 new roots over one centimeter is a very realistic goal.

SUMMARY

Seedling quality tests can provide valuable assistance to the grower to produce a quality product that has the best chance of survival and growth in the field. The recommended tests can best be utilized as follows:

Operation	Test	Objective(s)
Growing	-Morphology	-Meet targets from growth curves
	-Nutrient levels	-Ensure maximum growth rates -Avoid deficiencies/toxic levels
	-PMS	-Ensure maximum growth rates -Induce dormancy
Pre-lifting	-Morphology	-Desirable stock with set specifications
	-Cold-hardiness	-Predict storability
Pre-planting	-Root growth capacity	-Correlate to field performance

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