# New Stock Types and Advancements in the Bareroot Industry

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## Abstract

During the last twenty years, I've been involved in culturing and managing bareroot nurseries and I have observed several changes and developments in the culturing of stock to improve outplant survival. Below, I will describe some of the developments I have observed during this time frame.

## Introduction

In 1983, I started my nursery career at the Lone Peak Nursery in Draper, UT, which is approximately 20 miles south of Salt Lake City. The climate variations in this area are extreme. It has cold and snowy winters (with sub-zero temperatures) and hot and dry summers (with100 degree temperatures). While working at this nursery, I found that it was difficult to germinate seed, due to the short window of optimal spring weather for good bareroot germination. However, this was an excellent environment for the propagation of cuttings.

In 1987, I was hired as a culturist for the J. Herbert Stone Nursery which is located in Jacksonville, OR, west of Medford. This area had fairly mild winters, an average spring, but hot summers (with100+ degree temperatures). I found that this climate was good for germination of seed but the hot summers required irrigation cooling for some of the species to prevent them from burning.

In 1989, I was hired to manager the Humboldt Nursery, located in McKinleyville, CA, which is located approximately 20 miles north of Eureka. This area had very mild winters and mild summers with very little variances in temperature. Due to the mild climate and high humidity, it was an excellent environment for seed germination and seedling growth.

In 1993, I was hired to manage the IFA Nurseries in Toledo, WA. Toledo, located approximately 70 miles north of the Oregon/Washington state line, has the typical

four seasons. This area was warm in summer and had cold, wet winters. This area was good for germination but the potential for wet winters made lifting difficult at times.

In 1997, I became manager of the Webster Nursery, located in Olympia, WA. Olympia has the typical four seasons with cool, wet winters and mild summers. The sandy soil that exists on this site along with the mild climate provides an excellent bed for germination and provides good lifting despite the potential for a wet season during the winter months.

The basis and content of this paper are from my observations while working at these nurseries. The discussions I present are not necessarily the current operations of any specific nursery that is mentioned in this paper.

## Stock Types

I would like to start off by describing the nomenclature of the various stock types grown at the various bareroot nurseries. These stock types include:

1+0 is stock grown for one year in the bareroot field.

2+0 is stock grown for two years in the bareroot field in the same location.

2+1 is stock grown for two years in the bareroot field, lifted, processed and transplanted and grown for one additional year in the bareroot field.

1+1 is stock grown for one year in the bareroot field, lifted, processed and transplanted back into the bareroot field and grown for one additional year.

P+1 is a plug grown for one year in the greenhouse then processed and transplanted into the bareroot field and grown for one additional year.

## History Of Stock Types

When I first started at the Lone Peak nursery, the only stock type I cultured was the 2+0 seedling. This seedling was fairly low cost because there was not much involved in culturing it. However, over the years several changes in the culturing of this stock were made to improve the outplant survival and growth. One such change was growing the 2+0 at the proper density. I have found that growing the 2+0 at 25 live seedlings per square foot provided each seedling with the proper caliper without stiff laterals. Growing the 2+0 seedlings at a density of less than 25 seedlings per square foot encouraged the growth of lateral roots, which tended to stiffen during the second growing season. Stiff lateral roots on a seedling make it difficult to properly outplant in the field which lowers the potential for survival. The common practice was to sow the seedlings to produce a minimum of 25 seedlings per square foot and thin the seedlings at the end of their first growing season to the target density.

As time went on, sowing accuracy improved to better achieve the target density. The most popular machine to provide this sowing accuracy and used at many bareroot nurseries is the Oyjord seed drill. With the proper operations of this machine, the seed drill can provide fairly accurate sowing density. Other precision seed drills are on the market, but a manager needs to weigh the costs involved in the expense of these machines versus the benefit.

Another cultural improvement that transformed over the years to improve the 2+0 stock is root manipulation. Root manipulations include horizontal and vertical root pruning and root wrenching. From my observations, root manipulation not only encourages additional root growth but promotes the fine root hairs that seem to provide better outplanting success. If a 2+0 stock type is left to grow without any root manipulation, the seedling tends to grow a main tap root with minimal lateral or fine root growth. The root system tends to develop into the shape of a carrot at the end of the second year. In order to avoid this, the tap root needs to be severed at the end of its first growing season. The severing of the tap root not only encourages fine root growth, but it can also be used to manipulate the height growth. Severing of the tap root is severed by a horizontal root pruner.

In addition to the horizontal root pruner, roots can be trimmed using a lateral root pruner. This treatment will further encourage the finer root growth of the seedling.

Another operation used by some nurseries to encourage additional fine root growth is wrenching. This operation involves dragging a blade just below the seedling's root zone at an angle to lift the soil. The uplifting of the soil severs the fine root hairs, which encourages additional fine root growth. This uplifting by wrenching also stresses the

seedling which reduces top growth. With proper timing, this operation could take the place of top mowing in order to manipulate the height of the seedling. Top mowing has not been a favorite operation of mine, since it seems to reduce the seedling's bud formation.

Several studies have been conducted on improving the germination potential of conifer seed. If a seed's true germination potential can be accurately predicted, then the distribution of seed can be accurately sown to achieve the target density. One of the stratification methods that has proven to be effective to maximize the germination potential is the wet/dry stratification. This particular method includes soaking the seed at room temperature water for 24 hours and then placing the seed in 35 degree cold storage for 60 days. At the end of 60 days, the seed is dried down and then placed back into cold storage for an additional 60 to 90 days.

I have found that wet/dry stratification results in quicker, better and more uniform germination. With this stratification procedure, the germination potential of the seed can be more accurately predicted to meet the proper densities. This could eliminate the need to thin the seedlings to meet the desired growing densities.

Several studies have been done on the nutrients to maximize the growth and development of 2+0 stock. Such studies include the use of slow release fertilizers. This could certainly be beneficial but one problem I have observed is that slow release fertilizers are temperature activated. When the 2+0 seedlings require nutrients in the early spring, the slow release fertilizers have not yet been released, because the soil temperatures are not warm enough. I believe that additional research and studies need to be done to maximize the benefits of slow release fertilizers with bareroot stock.

Over the years, the 1+1 stock type has emerged as a popular and beneficial stock type. The 1+1 seedling is a little more expensive than the 2+0 seedling due to the additional operations required. The 1+1 seedling needs to be lifted, graded, root pruned, packed and transplanted during the transition from the first to the second year. This is an expensive, additional operational cost.

At the Webster Nursery, the 1+1 seedlings are transplanted at a density of 24 seedlings/bed foot or six seedlings/sq. ft. This density has proven to produce a seedling with good caliper, good bud size and a balanced root/shoot ratio. The advantage of a 1+1 seedling is that the seedling has more stored food reserves which result in faster growth during the first year after the seedling is outplanted. This faster growth can be an advantage when there is vegetative competition or a problem with animal browse.

Another benefit of the 1+1 seedling is that it has a more fibrous root system, or a "mop" root as it is sometimes referred. The fibrous root system can be attributed to the uniform pruning on the pruning table while the seedlings are graded at the end of the 1+0 season. This table pruning is more uniform and accurate than the pruning done on the 2+0 stock in the field, because the seedling is out of the field and aligned during the grading and pruning processes. At the end of the first year, the seedlings are lifted, graded and then transplanted back into the ground. By placing the seedlings at the proper depth and density, the likelihood of stiff laterals is minimal.

One of the improvements in the 1+1 stock type over the years is an earlier sow date. With the wet/dry stratification, not only does the seed germinate faster, but it also has the ability to germinate during cooler soil temperatures when the mycorrhizae is active. These advantages would provide a bigger 1+0 stock, which sets the stage for growth during the second growing season when the seedling is a transplant.

Another improvement of the 1+1's over the years includes the timing of transplanting. This is especially true if there is a potential for a short growing season. The earlier the 1+0 seedlings can be transplanted, the better development of the seedlings.

As time progressed, I experienced the transplanting of plug stock to produce P+1 seedlings. This particular stock type has one of the higher associated costs due to the fact that it has both the greenhouse costs plus the transplanting costs. Some of the advantages and benefits of using a P+1 over the two previously mentioned stock types is that it is beneficial for species that are hard to germinate in the field, such as western redcedar. Western redcedar does not seem to have a consistent field germination potential from one year to the next. Part of the reason for this

could be the differences in climate when western redcedar is sown in the field. To eliminate this variable, the seed is sown in the greenhouse where a consistent temperature, conducive for germination, can be maintained.

Another advantage in using the P+1 stock is for slow growing species. Species that typically grow slowly in the field and need three or more growing seasons to reach optimal outplanting height. By providing the desirable growing conditions in the greenhouse, slow growing species can reach their target height in a shorter time frame.

Another improvement in using the P+1 stock type includes the shaking out of the greenhouse media prior to transplanting. I've notice that when plug stock is planted with the original media intact, the root system does not seem to grow and develop as well as when the greenhouse media is shaken off prior to transplanting. It seems that the shaking out of the media encourages and stimulates root growth. Caution needs to be taken, when shaking out the media, so the seedlings are not beaten. Rough handling and beating of the seedling to remove the media may cause more damage than the potential benefit of removing the media.

Another improvement that has developed was the ability to fall transplant plug stock. My first impression when I first heard about fall transplanting was that the stock should be transplanted as late as possible to reduce the possibility of the seedling desiccating once it was transplanted. When more experience and studies were conducted on fall transplanting, it was learned that, with the proper irrigation practices, plug stock can be transplanted as early as the second week in July, which is a standard practice at the Webster Nursery. The advantages of early fall transplanting are that the seedlings seem to develop a larger caliper, bud and root system and the seedlings become established and prepared for the oncoming winter.

## Costs

Competition in the bareroot seedling industry has intensified in the last few years, especially since the overall timber cut has been declining. In order to stay competitive, nurseries need to keep a handle on costs. The bulk of the seedling charges from the nursery is to recover much of the labor and material spent on the crop. Labor costs are a large portion of a nursery's operating budget. Each nursery needs to find the most efficient and effective means of processing and culturing the stock. There are several options available to nurseries to accomplish this, and some are more reliable and cost effective than others.

One approach is to directly hire employees. I have found that the costs to utilize direct hired employees are approximately 60% of the overall costs for the nursery. The cost for direct hires not only include the employees' salary, but also the overhead costs which support the employee. Some of these costs include unemployment, insurance against injuries (such as L & I or OWCP), and costs for hiring (advertising, reviewing applications, interviews, skill tests, drug tests and physicals).

Another problem a nursery may face in utilizing direct hires is that it may be difficult to recruit during a period of low unemployment. In1999, it was difficult to recruit at Webster Nursery due to the fact that unemployment in the Olympia area was less than 3%.

Another way to accomplish labor needs is to contract. An advantage of contracting is that there is less overhead cost. There is no hiring, orientation or training of employees. These are operations that are the responsibility of the contractor. There are also lower production costs due to the fact that there are no unemployment, insurance or injury costs. These elements are usually the responsibility of the contractor. The other advantage is that there are usually higher production rates. To a contractor, time is money. The contractor's primary goal is to get the job done and move onto another job.

One of the disadvantages of contracting is that there is less control over the work. A manager usually cannot direct the contractor's employees as they can with their own hired employees. However, this can be overcome by a well-written contract, which identifies specific work details needed for the particular job. Another way that this lack of control can be over come is by implementing good inspection procedures, and to specifically identify these procedures in the contract.

Another disadvantage to contracting the labor is the possibility of obtaining a poor contractor. The contract may be

awarded to a contractor who underbids the job and is not familiar with the type of work that they bid on. The contractor may determine that they are losing money and try to take short cuts to minimize their loss. The way to avoid this is a well-written contract specifying the grounds for default if the criteria for the contract are not met.

A manager must maintain low enough prices to stay competitive but yet earn enough through the sale of seedlings to cover operational expenses and capital improvements. On the other hand, the manager needs to be careful not to price themselves out of the bareroot market. Manager's of American nurseries must be concerned with the low prices that are coming from the Canadian market. Some private nurseries in Canada are able to sell plug stock at a price similar to the American bareroot cost.

## Future Trends

If a manager wishes to stay away from labor headaches, there is always the hope of perfecting Machine Vision. Machine Vision is an instrument used to sort and grade bareroot seedlings. It uses infrared imaging to match the acceptable seedlings as they are run through the machine. The current users of the machine report that it is relatively quick and accurate. However, the set up prior to grading the seedlings is slow. Set up also has to be repeated each time the grade changes from one stock type to another.

Machine Vision has the capability of sorting different grades or size classes of seedlings. Machine Vision is currently being used for quality control measurements at the J. Herbert Stone Nursery.

Another concern each bareroot manager needs to prepare for is the restriction on the use of methyl bromide. Methyl bromide, a soil fumigant, is used by the majority of the bareroot nurseries to rid their fields of pests that are detrimental to health of the bareroot crop. Methyl bromide will be banned in 2004, as it is a contributor to the break down of the ozone layer. The removal of methyl bromide will have a great impact on the bareroot market, because of its reliability in the health of the bareroot crop in most bareroot nurseries.

As a result of the removal of methyl bromide, I believe there will be an increase in greenhouse stock. Growing stock in a greenhouse environment provides a germinating seed more protection from pests than what would exist in the bareroot fields. When methyl bromide is removed from the market, I feel there will be a sharp increase in bareroot prices to cover mortality that may occur. As of this writing, there are no viable alternatives on the market to replace methyl bromide. Each manager should concentrate on a good pest management plan for their nursery to prepare for the removal of methyl bromide.

Another change I feel the bareroot industry is facing is the increased need for diverse species. The production of more diverse species means more complex culturing. A factor that will make this intense culturing more difficult is that the quantities of diverse species will never amount to a large number. Culturing several different species in small to moderate quantities will make care and culturing more difficult.

## Future

In order for any bareroot nursery to remain viable and competitive in the nursery industry, they must offer seedlings at a competitive price but still maintain an efficient operation. At the same time, a bareroot nursery must provide good quality. I believe that most customers don't mind paying a little more for their stock as long as they get the quantity and quality seedlings they request.