TECHNIQUES OF QUALITY CONTROL FOR SEEDLING LIFTING OPERATIONS [1]

John H. Hinz[2]

ABSTRACT

Describes methods and rational for monitoring seedling quality during lifting operations at a Southern Idaho forest nursery. Includes descriptions of methods for measuring dormancy and plant moisture stress and provisions for protection of stock during lifting and transport to packing shed.

INTRODUCTION

Since the reforestation process is especially sensitive to any mistakes made in the rearing or handling of planting stock, the prudent nursery manager is well advised to monitor the effects of his/her practices upon the quality of the finished product. Each phase of nursery operation offers its own unique set of problems and opportunities with regard to quality control. This paper describes the quality control techniques used at a Southern Idaho forest nursery during a particularly critical phase of the reforestation process: seedling lifting.

Built in 1960 as the U.S. Forest Service nursery for the Intermountain Region (R-4), Lucky Peak provides the majority of the seedlings used for reforestation projects in that region as well as contributing to the efforts of the Southwest Region (R-3), the Pacific Northwest Region (R-6) and several other agencies, including BLM, and Idaho Fish and Game. Production in recent years has been on the order of 9 to 11 million 2-0 seedlings. With the reduction in reforestation backlogs, and with the nursery at Albuquerque producing seedlings for R-3, Lucky Peak production will probably stabilize at somewhere between 6 and 8 million seedlings per year. Species produced include most of the common western conifers, particularly lodgepole pine, Douglas-fir, and ponderosa pine, as well as several species of native shrubs. Most seedlings are spring-lifted, though a small fall lift (1-2 million seedlings) is usually conducted.

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[2]Forester, U.S.D.A., Forest Service, Boise National Forest, Lucky Peak Nursery, Boise, Idaho.

PROCEDURES

Lifting is done primarily with contract labor and proceeds as follows: Seedlings are undercut to a depth of about twelve inches with a standard tree-lifting blade drawn by a crawler tractor. This is followed by a wheel tractor drawn Egedal lifter/ shaker which vibrates to loosen the seedlings in the soil. The lifting crew then lifts the seedlings by hand, shaking the soil free from the roots and placing them immediately into plastic boxes layered with wet burlap. As soon as possible these boxes are loaded onto trailers and taken to the seedling coolers, where they are segregated by source and stored at 34°F until they can be graded and packed.

Quality controls associated with the lifting operation can be separated into two general categories:

1. Monitoring the physiological condition of the seedlings.
2. Protection from injury.

The primary concerns with respect to physiological condition of seedlings are dormancy and plant moisture stress. The conventional wisdom in reforestation is that, other things being equal, seedlings which are lifted during their dormant period are better able to withstand the shock of lifting, packing, storing, and planting than are seedlings which are lifted during a period of activity.

At Lucky Peak Nursery seedlings usually enter dormancy in early to mid-November, breaking dormancy anywhere from late February to mid-March. Ideally, lifting would be done sometime between these two dates. Unfortunately, Lucky Peak is situated such that, very shortly after the seedlings enter dormancy the soil freezes, preventing lifting. Usually it remains frozen until just a few days prior to the time when the seedlings break dormancy in the spring. Thus, if seedlings are to be lifted while dormant, the lifting must be done in a very short period of time.

Because of this situation, seedling dormancy is monitored very closely as the season for fall lifting approaches so that lifting can begin as soon as the seedlings are dormant. For the past several years a portable oscilloscope and square wave generator has been used to determine the degree of dormancy within the seedlings. This technique (Ferguson, Ryker, and Ballard, 1975) requires the interpretation of a square wave pattern on an oscilloscope screen which, having been transmitted through the seedling with a needle-like probe, changes shape in response to the physiological activity within the plant. Though its validity as a measure of dormancy has not been universally accepted by plant physiologists, the oscilloscope technique provides a useful guide to the practicing nursery manager in deciding when to start lifting operations.

Since 1979 we have also been using the Missoula Equipment Development Center dormancy meter as a supplement to the oscilloscope. This instrument utilizes a probe similar to that on the oscilloscope, but has the advantage that it gives numerical readouts supplemented by lights indicating "Dead", "Dormant", or "Active", so that interpretation of wave patterns is not necessary. Being neither an electrical engineer nor a plant physiologist I am ill-equipped to comment upon the validity of this device in an absolute sense, however, I have observed that readings taken with the dormancy meter generally agree with oscilloscope readings taken on the same plants.

In addition to using the oscilloscope and dormancy meter to determine when to commence fall lifting operations, these instruments are also used to monitor the state of seedling dormancy during the spring lift. While an indication that seedlings are breaking dormancy during the spring lift will not allow us to lift them any faster (this is usually controlled by field and weather conditions), such information is useful in that it can tell a receiving forest that a given lot of seedlings may be particularly sensitive to mishandling.

Plant moisture stress is also closely monitored during lifting operations. Though a pressure bomb is available at Lucky Peak, it is used for testing seedlings during the packing operation and just prior to shipping. Field testing for PMS is done using the Model J-14 press, manufactured by Campbell Scientific, Inc., Logan, Utah. These measurements are taken on each seedlot prior to undercutting, after undercutting, after lifting, and as the seedlings are placed in cold storage prior to packing. This procedure allows us to determine if mistreatment of stock resulting in increased plant moisture stress has occurred at any point in the lifting operation. We consider any PMS reading above 10 atmospheres to be indicative of problems. Using this information we can correct any systematic mistreatment of the stock and be aware of possible damage to any seedlot.

That the J-14 press provides readings exactly equivalent to those provided by the pressure bomb is not a universally accepted fact. Our quality control people who use both instruments side-by-side to test seedlings during the packing operation have consistently obtained very similar readings. A random sample of ten seedlots tested with both instruments (ten readings taken per seedlot with each instrument for each of ten seedlots) over the past two packing seasons by an assortment of individuals yielded a correlation coefficient of .88. However, midday readings taken on growing seedlings in the field during the summer of 1980 have shown that, when the pressure bomb readings have started to approach 15 atmospheres, readings with the J-14 have been significantly lower, reading about 7-9 atmospheres. Though I do not yet have enough data to draw any firm conclusions, if this relationship proves to be consistent, our use and interpretation of the J-14 press will have to be modified.

Besides monitoring the physiological condition of seedlings, every effort is made to protect them from injury during the process of lifting and transport to the storage coolers. As most lifting is done with contract labor, several contract clauses have been developed to protect the seedlings from careless mishandling. Under the contract, lifters can be fined for any of the following infractions:

1. Lifting less than two handsful.
2. Excess soil on seedling roots.
3. Abuse of seedlings to remove excess soil.
4. Failure to properly cover lifted seedlings.
5. Piling seedlings on the ground.
6. Exposing roots to the air for longer than 20 seconds.
7. Leaving any seedlings in beds.
8. Walking on seedlings.

The contract outlines specific procedures for lifting and provides plenty of leeway for the nursery to halt operations if field or weather conditions become detrimental to the condition of the seedlings.

Lucky Peak Nursery has several inherent characteristics which inhibit quality during lifting. In addition to the limited time period when suitable lifting conditions coincide with seedling dormancy, foremost among these is the soil, which has a very high clay content. This causes excessive stripping of fine roots, a situation which has been at least partially alleviated by the use of the Egedal lifter/shaker. The fine textured soil is also very sensitive to conditions of high soil moisture, draining very slowly and becoming almost like glue when wet.

At the least this results in a slowdown of the lifting operation, frequently to the extent that dormancy is broken in the spring, accompanied by much stuck equipment and a general gnashing of teeth among all concerned. Careful planning combined with having a well-trained and resourceful field crew have helped us work around this problem. Half-track units on our lifting tractor and a crawler tractor-mounted winch have also demonstrated their value several times over.

There is sometimes a slight delay in bringing the freshly-lifted stock from the field to the storage coolers. This is caused by a particularly fast lifting crew or by field conditions which prevent the rapid loading of seedling boxes onto trailers. This is potentially a very serious problem as the seedlings may, even though they are covered by wet burlap, start to heat up, causing moisture stress. Construction of additional trailers for hauling seedlings from the field and the rental of extra tractors during the lifting season has reduced this problem. The purchase of a tractormounted forklift to load boxed seedlings onto the trailers in the field is expected to speed up their transportation.

Another bottleneck occasionally develops when the amount of freshly-lifted seedlings arriving at the cooler exceeds the capacity of the coolers. With the usual pressure to lift seedlings while they are dormant, it isn't possible to simply shut down the lifting until more cooler space can be made available by packing and shipping the seedlings. While many things have been attempted to alleviate this situation, including placing seedling boxes under sprinklers on the loading dock, the long-term answer is additional cooler space. Requests for funds to construct an additional cooler in fiscal year 1980 have been denied.

DISCUSSION

Quality control efforts at Lucky Peak Nursery do not begin and end with the procedures outlined here. Plant moisture stress, shoot/root ratio, height, caliper, and dormancy tests are conducted during the packing operation. Storage temperatures are monitored continually. Indeed, every phase of our work from seed processing to shipping has some effect upon the quality of the stock we produce. We are well aware of this fact and make every effort to learn the consequences of our actions and to modify them where necessary.

Still, improvements can be made. A comprehensive study of dormancy, plant moisture stress, and the instruments used to measure them would be welcomed in order to clarify the role of these phenomena in reforestation and to reduce confusion as to their measurement. Growth chamber or root growth capacity tests of each seedlot might also be desirable. As our ability to use existing knowledge about successful seedling culture and reforestation techniques improves, and as new knowledge become available, the quality of our product will surely improve.

PUBLICATIONS CITED

Ferguson, Robert B., Russell A. Ryker, and Edward D. Ballard.
1975. Portable oscilloscope technique for detecting dormancy in nursery stock. USDA Forest Service General Technical Report INT-26, 16 P. Intermountain Forest and Range Experiment Station, Ogden, Utah.