Measuring Tree Seed Moisture Content Now and in the Future

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Abstract.-- The procedure used in developing conversion charts for tree seed for use with a relatively inexpensive electronic seed moisture tester is given. A list of the species for which charts have been made is given. A brief discussion is presented on the potential future uses of regulating seed moisture.

INTRODUCTION

The regulation of seed moisture is critical to the management of high quality seed. Mechanical injury or high temperatures can have detrimental effects to be sure, but the moisture content of seeds no doubt is the most influential of all the factors that can effect the quality of seeds (Justice and Bass, 1979). The date of harvest of cones, fruits, or seeds is generally related to moisture content. Conifer cones must be air dried to a specified range of moisture content in order to produce maximum yields and highest quality seed. Kiln drying of cones that are too high in moisture content will result in case hardening of the cone and a poor seed yield. Most temperate zone species that have moisture contents below 10 percent can be stored at cold temperature for years while seed at high moisture content will live only a few months even with ideal temperatures. These are but a few brief examples of how critical the regulation of seed moisture is to the quality of seed.

ROUTINE SEED STORAGE

For routine seed storage the seed handler is concerned with maintaining seed basically at a threshold moisture level. For the vast majority of temperate species this threshold value is 10% on a wet weight basis. Extremely low values of 2 or 3% might lead to seed damage according to some reports, but data (Justice and Bass, 1979, Benson, 1970) exists that shows that this is probably not the case. The examples of loss of viability due to low moisture content are probably explainable as imbibitional injury when planted. A slow uptake of water would allow those seeds with ultra low moisture contents to maintain a high level of viability.

A desirable test for moisture is one that is fast, inexpensive, and gives acceptable accuracy. There are a number of electronic moisture testers available that will give quick results. However, they generally cost about $1,000 or more. For the small forestry operation this might represent a substantial portion of the annual budget for equipment. So for many the $1000 meter may not be inexpensive. Also none of the meter manufacturers concern themselves with forestry and conservation seeds in the calibration of their meters. Therefore, the meter will not be useable until someone conducts the necessary measurements to relate meter readings to actual seed moisture contents.

For many years a small meter was available for which the National Tree Seed Laboratory had developed conversion charts. This was the PB-71 made by the Eaton Corporation. It was marketed under a number of names: Dole, Radson, Burrows, and Gilmore-Tatge. Unfortunately this meter was improved for the tester of grains, and tree and shrub seed testers could no longer use it. The electronic parts were modified such that they no longer functioned in the range needed for woody plant seed. To quickly replace this much needed meter, an effort was made in cooperation between the National Tree Seed Laboratory and many private and public agencies to develop conversion charts for another relatively inexpensive meter, the Dickey-John[2] grain moisture tester for corn. The following have donated seed for this work: R. W. McPhearson, California Division of Forestry, Michigan Department of Natural Resources, Dean Swift Seed Company, Louisiana Forest Seed Company, W.W. Ashe Nursery, J. Herbert Stone Nursery, J.W. Toumey Nursery. The effort to develop charts is still going on, and the NTSL will be happy to develop a chart as soon as possible if your desired species are not on the charts.

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[2]Use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

DEVELOPMENT OF THE CONVERSION CHARTS

The procedure followed in developing the moisture charts for the Dickey-john meter was based on the following reasoning. 1. The variation in meter readings among samples from the same seed lot and among seed lots at any given moisture content would be small (less than one percent moisture). If variation was large then the meter would not be useful because multiple readings would be required, and the meter would not be a quick test. 2. It follows from the first statement that the samples tested in the meter could all come from one seed lot if that seed lot was at all representative. 3. The concern in storing tree seed is that the moisture content be below a given threshold value. Therefore, whether the true moisture is 5, 6 or 84 is not important. What is important is that we are certain that the value is below the critical threshold. Our primary concern in developing these charts was, therefore, not necessarily to have a high degree of precision but to have numbers that will tell us that we have our seed dry enough for long term storage.

The first step in developing the charts was the selection of a seed lot that was of good average germination and purity for the species. This seed lot was then soaked overnight in water to fully imbibe the seed. The water was drained off, and the seed was placed on the seed drier. As soon as the seed was surface dry, a reading was taken on the meter and in the drying oven. The drying oven moisture determination wash done on duplicate 5 gram samples at 103°C ± 2°C for 17 hours ± 1 hour (International Seed Testing Association, 1985). Generally the moisture content was in the neighborhood of 20 to 25% on the first reading. Subsequent readings were taken every one to two hours depending on how fast the drying was taking place. Readings were taken until the seed reached moisture contents of 4 to 6%. In some cases the end moisture content achieved was only 7 or 84. Some of the species tested had a conversion chart developed for the PB-71 meter. Readings from the PB-71 served as a check that the seed lot being used was representative of the species. The reasoning on that point was this. If the reading from the PB-71 was within tolerance with the oven reading, then there was confidence that the seed lot being used was representative. In all cases the readings were within tolerance so that the procedure of using one seed lot seems valid.

The second step was the regression of the meter readings on the moisture contents determined by the oven procedure. This regression produced a prediction equation for calculating the meter readings from oven measurements. Using oven measurement values from 6 to 18% in steps of 0.5% a set of meter readings was computed from the prediction equation. The computed values are the conversion chart values. The measurements made with the Dickey-John meter on several loblolly pine seed lots agree with the readings found by the oven, and show that the procedure is appropriate.

Conversion charts have been made for the following species:

WESTERN SPECIES

Abies concolor
Abies grandis
Abies magnifica
Calocedrus decurrens
Picea engelmannii
Picea sitchensis
Pinus contorta
Pinus coulteri
Pinus Jefferyi
Pinus lambertiana
Pinus muricata
Pinus ponderosa
Pinus radiate
Pseudotsuga menziesii

NORTHERN SPECIES

Betula paperifera
Betula allegheniensis
Larix laricina
Picea shies
Picea glauca
Picea mariana
Pinus banksiana
Pinus resinosa
Pinus strobus
Thuia plicata
Tsuga canadensis
Crataegus phaenopyrum

SOUTHERN SPECIES

Pinus clausa
Pinus elliottii
Pinus palustris
Pinus taeda
Pinus virginiana

Persons needing the charts may obtain them from the National Tree Seed Laboratory, Rt. 1, Box 182B, Dry Branch, GA 31020.

REGULATION OF SEED MOISTURE CONTENT IN THE FUTURE

To this point we have talked about regulating seed moisture as a very basic technology. We wanted only to maintain our seed below a given threshold of moisture so that we could safely have long term storage of seed. This is an extremely important aspect of seed moisture that will stay with us for as long as we store seed in the manner we currently do.

During the last 10 years, however, the literature has had some articles on regulating moisture content of stratified seed that allows the nursery manager to store seed while either maintaining the benefits of stratification or even enhancing the benefits of stratification. Danielson and Tanaka (1978) found that by air drying stratified seed of Douglas fir and ponderosa pine that the seed could be stored for up to 9 months without reinstating dormancy or causing deterioration of the seed. Belcher (1982) confirmed the findings of Danielson and Tanaka with Douglas fir and found the same to be true for loblolly pine. De Hatos Malavasi et. al. (1985) showed that seedlings produced from air dried Douglas fir seed were larger at age 5 days than seedlings from seed which were stratified only. Numerous studies on improving the vigor of seeds by priming with PEG have been reported in the literature. It seems quite likely that the improvement in vigor might come from an effect brought on by the PEG regulating the moisture content of the seed. It is also well established that the moisture content of the seed and its various constituent parts has a profound control over the condition of the cell membranes and the metabolic and chemical activities that occur within the seed (Priestly, 1986).

In the future it is very likely that seed handlers will want to regulate the seed moisture for purposes of regulating the effects of the presowing treatments. Today's forms of stratification could well be replaced with more sophisticated procedures. To do this we will want to measure moisture in ranges between 20% and 30% or 40%. A type of meter like the Dickey-John will allow for quick measurements in this range. Therefore, as the seed physiologists discover the critical moisture contents to regulate seed performance, the technology exists to adapt this new information for practical application by the nursery manager.

LITERATURE CITED

Belcher, E.W. 1982. Storing stratified seeds for extended periods. Tree Planter's Notes 33(4): 23-25.

Benson, Darrell A. 1970. Sixteenth Annual Report, Eastern Tree Seed Laboratory, USDA Forest Ser vice. pg. 6.

De Matos Malavasi, Marlene, Susan G. Stafford, and D.P. Lavender. 1985. Stratifying, partially redrying and storing Douglas-fir seeds: effects on growth and physiology during germination. Ann. Sci. For. 42(4):371-384.

Danielson, H. Rodger, Yasuomi Tanaka. 1978. Drying and storing stratified ponderosa pine and Douglas-fir seeds. Forest Science 24(1):11-6.

International Seed Testing Association. 1985. International Rules for Seed Testing 1985. Seed Science and Technology 13(2): p. 338 - 341.

Justice, Oren L. and Louis N. Bass. 1978. Principles and practice of seed storage. U.S. Department of Agriculture Handbook No. 506. 289 p.

Priestly, David A. 1986. Seed Aging, Implications for Seed Storage and Persistence in the Soil. 304 p. Comstock Publishing Associates, Ithaca, NY.