IMMERSION DETERMINATION OF SEEDLING ROOT-TOP RATIO' AND ITS CORRELATION WITH A DROUGHT RESISTANCE INDEX

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The survival potential of field planted nursery stock depends, in large degree, upon its root-top ratio, i.e., the size and capacity of roots to provide a sufficient supply of water to balance the transpirational loss of crowns. It has been pointed out more than once that root-top ratio (R/T) determined on a weight basis is not always a reliable indication of the drought resistance of planting stock (*1*). Also, dry weight analyses require expensive ovens and balances, and a lapsed time of nearly 2 days for accurate determinations; however, volumes can be determined more quickly with cruder equipment. These considerations led the senior author to suggest a simple and rapid immersion determination of the volumetric root-top ratio, described in this note. The method was developed at Wind River Nursery, Carson, Wash.

Volumetric ratio determination

The analytical equipment includes a metal or a plastic container, large enough to accommodate either roots or crowns of nursery stock to be analyzed, and a piece of lead, weighing approximately 200 or 250 g, to serve as a sinker. In most cases, a container of 7-inches diameter and 18-inches height with a volume of about 2-½ gallons, or 10 liters, is sufficient. Near its top, the container is provided with a faucet-shaped discharge tube (fig. 1). The sinker has a hole or an eye for attachment of a clamp or a hook and a 2-foot long string. For the sake of convenience, the sinker should be cut so its volume, together with the clamp, attains a round shape such as 20 or 30 cubic centimeters.

The number of trees used in each analysis varies from 10 to 30, depending on their size. In operational use, trees for analyses are taken from the grading belt after culls have been removed. Thus, the determined root-top ratio would indicate to field foresters what to expect on the average.

The trees are washed in a stream of water to remove adhering soil particles and to preclude a decrease of the container's water by its absorption into dry tissues. The excess of water is removed by shaking or blotting the trees. In analyses aiming at maximum accuracy, roots are separated from tops at the ground line. The container is filled with water, permitting some of it to escape via the discharge tube. The roots are tied near their thick ends with a string, the sinker with the long string is attached to them, and the root bundle is immersed in the water. The discharged water is collected in a graduated cylinder, and the volume of roots minus the volume of the sinker assembly is recorded in cubic centimeters. The same procedure is employed in analyses of tree crowns. The addition of a household detergent (1 gram per liter) to the water would minimize the entrapment of air bubbles.

The method described above can be modified by using the entire tree, and simply making successive hand immersions of roots and tops. This procedure, at a slight cost in accuracy, saves time as well as the trees used in the analyses.

Illustrative analyses were performed with 2-year-old jack pine, Pinus *banksiana,* and 3-year-old red pine, *Pinus resinosa*, seedlings. The lifted stock of each species comprised 300 trees; 150 of these of average size were taken for analyses, 15 trees for each determination. The results are given in table 1.

Standard deviations, calculated with n-1 as the denominator, reveal an acceptable reliability of the method. The analyses indicate excessive growth stimulation of tree crowns, probably inflicted by either eradicants or nitrogen fertilizers; subsequently, R/T is lower than desired for the best field survival of trees.

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Correlation of volumetric R/T with a drought resistance index

The results of immersion analyses were compared with the results of quadruplicate determinations of the index of drought resistance of trees (*1*), i.e., the ratio of the weight of foliage, partly dehydrated during 24 hours in a ventilated oven at 60° C, and the titration value of roots determined by saturation of roots with 3.0 *N* hydrochloric acid and back titration with 0.3 *N* sodium hydroxide (2). The average values obtained by the two methods are as follows:

Jack pine, volumetric R/T ratio:

$$\frac{5.1}{26.6} = 0.19$$

Jack pine, dehydration-titration R/T ratio:

$$\frac{0.42}{9.6} \times 100 = 4.4$$

Red pine, volumetric R/T ratio:

$$\frac{9.0}{41.6} = 0.22$$

Red pine, dehydration-titration R/T ratio:

$$\frac{0.80}{13.8} \times 100 = 5.8$$

According to recent observations under Wisconsin conditions, planting stock of an acceptable survival potential should have a drought resistance index approaching 7.0. A coefficient of 0.04 will serve to convert the values of the drought resistance index into approximate values from immersion analyses; in our case, 4.4 X 0.04 = 0.18 and 5.8 X 0.04 = 0.23 are entirely acceptable values.

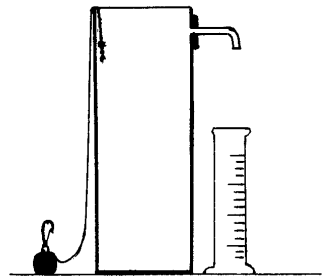

Figure 1.—*Equipment for immersion determination of the root-top ratio of planting stock.*

Table 1.—*Volumetric root-top ratios of 2-year-old jack pine and 3-yearold red pine seedlings determined by immersion method (results per average seedling)*

Jack pine			Red pine		
Volume of Roots	Tops	Root-top ratio	Volume of Roots	Tops	Root-top ratio
(*ml*)			(*ml*)		
4.7	25.8	0.18	8.3	40.7	0.20
4.5	24.0	0.19	10.3	43.4	0.23
5.7	29.1	0.18	10.5	43.1	0.24
7.0	31.5	0.23	7.2	38.5	0.18
3.9	24.0	0.16	8.4	41.0	0.24
5.0	25.1	0.20	9.5	42.9	0.22
AVERAGE					
5.1±0.92	26.6±3.8	0.19±0.024	9.0±1.30	41.6±1.98	0.22±0.024

Conclusions

Gravimetric-titration and volumetric methods provide closely related information. The volumetric method has a decisive advantage; it eliminates the time-consuming drying, weighing, and titration. In turn it may well serve for a rapid appraisal of the potential of nursery stock to cope with adverse effects of drought and closely related effects of frost and winterkill. Foresters familiar with problems of reforestation should appreciate the significance of the results given above, which reveal the poor morphology of the analyzed stock. Reforestation material of an acceptable quality should probably have a volumetric root-top ratio in the proximity of 0.30 for most Wisconsin planting conditions.

Literature Cited

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