Evaluation of Growing Media for Culturing Containerized Red Pine and White Spruce

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Evaluation of six growing media indicates that a 1:1:1 sphagnum peat moss, peat moss, and vermiculite mix and Forestry Mix result in highest quality red pine seedlings. Best white spruce seedlings were grown in Forestry Mix, Jiffy Mix, and 1:1:1 mix.

The importance of containerized tree seedlings in reforestation programs is increasing every year. However, there is still a need to evaluate various growing media for some species such as red pine *(Pinus resinosa* Ait.) and white spruce *(Picea glauca* (Moench) Voss). These species are widely planted in the Lake States, the Northeastern United States, eastern Canada, and the Prairie Provinces. Therefore, the primary objective of this study was to evaluate selected soil mixes for growing containerized red pine and white spruce seedlings.

Methods

Red pine and white spruce were grown in BC/CFS styroblock-2 quarterblock containers filled with one of six different growing media with four replications per treatment. The growing media evaluated were:

1. Jiffy Mix, a commercially prepared mix with equal parts sphagnum peat moss and vermiculite.
2. 1:1 (by volume) peat moss (and vermiculite (P-V).
3. 2:1 P-V.
4. 3:1 P-V.
5. 1:1:1 sphagnum peat moss, peat moss, and vermiculite (S-P-V).
6. Forestry Mix, a commercially prepared mix (Redi-Earth Peat-Lite Mix) composed of equal parts sphagnum peat moss and vermiculite.

The peat moss in the noncommercially prepared mixes was screened to obtain uniformity of texture. Tests were run on samples of the growing media to determine pH and physical properties (table 1). Techniques adapted from Carlson (*1*) were used for determining physical properties. The pH was measured when the growing media were loaded into the containers and again at the end of the growing period.

Ash content, which is a measure of mineral elements present, was much higher for Jiffy Mix and Forestry Mix than all other mixes. This is also reflected by the relatively high initial pH of these mixes. Jiffy Mix, 1:1:1 S-P-V, and Forestry Mix had lower bulk densities, greater pore volumes, and greater moisture capacities than the other three mixes, probably because of the sphagnum peat moss component in them.

The trees were grown in a greenhouse with a photoperiod of 20 hours. The photoperiod was established 2 weeks after germination. Also at this time, a fertilizer regime was begun with application of 20-20-20 (NPK) at a ratio of 1:128 (57.7g/l) with each irrigation. Temperature inside the greenhouse was regulated between 21 and 24° C as constantly as possible.

The seedlings were in the greenhouse for 29 weeks and then set outside for 1 week after which 10 seedlings were selected at random from each replicated treatment (soil mix), resulting in 40 trees per soil mix of each species.

The seedlings were extracted and the following parameters were measured:

1. Stem height was measured from root collar to tip of terminal bud to the nearest 0.1 centimeter.
2. Stem caliper was measured at root collar to the nearest 0.1 millimeter.
3. Shoot and root weight was measured to the nearest 0.001 gram after shoots and roots were ovendried for 48 hours at 65° C.
4. Shoot-root ratio was ob-

Table 1.—*Physical properties and pH of study mixes*

Growing media	Initial pH	Final PH	Ash content	Bulk density	Specific gravity	Pore volume	Moisture capacity	Air capacity	Coarse fine ratio	Initial water content
				g/ml	g/ml	%	%	%		%
Jiffy Mix	6.4	5.6	68	0.09	2.15	96	59	37	0.2	2
1:1 P-V	4.8	4.7	29	.14	1.72	92	52	40	.4	4
2:1 P-V	4.4	4.2	18	.15	1.63	91	50	40	.9	4
3:1 P-V	4.3	4.2	19	.16	1.64	90	52	39	1.0	5
1:1:1 S-P-V	4.4	4.4	26	.10	1.70	94	55	38	.5	6
Forestry Mix	5.4	5.7	56	.06	2.00	97	54	42	.1	9

tained by dividing ovendry weight of shoots by ovendry weight of corresponding roots.

4. Styroplug quality ratings were determined from an index, which considers ease of removal of the plug from containers, root development, and plug consistency. Plug ratings are as follows:

   Excellent—4. Styroplug is easily removed from container cavity, yielding a firm soil-root mass that conforms completely to cavity shape and can be handled without breaking apart. Soil is present throughout the entire cavity with roots extending to the bottom of styroplug.

   Good—3. Same as rating 4, except styroplug fills only between 75 and 100 percent of cavity. Roots are well developed, and extend to bottom of partial styroplug.

   Fair—2. Styroplug can be removed from cavity but roots are not well enough developed to hold the soil-roots mass together and handling causes it to break apart.

   Poor—1. Styroplug cannot be removed from cavity without destroying it because of poor root development.

5. Quality index rating was originally recommended for use with bare-root stock (*2*). It incorporates most of the above measurements into one value using the following equation:

$$Q\ (\text{quality}) = \frac{\text{stem weight (g)} + \text{root weight (g)}}{\frac{\text{stem height (cm)}}{\text{stem caliper (mm)}} + \frac{\text{stem weight (g)}}{\text{root weight (g)}}}$$

   Increasing quality index ratings indicate higher quality seedlings. This rating system has been used with containerized seedlings and it has been

suggested that seedlings with a quality index rating less than 0.09 are unplantable and would not survive under field conditions (*5*).

Differences in stem caliper, stem height, stem weight, root weight, and shoot-root ratio for each soil mix and species were evaluated by analysis of variance techniques at the 0.05 level.

Results

Red pine. Forestry Mix yielded seedlings that had significantly larger stem calipers, heavier root weights, and smaller shoot-root ratios than all other mixes (table 2). It also produced seedlings with statistically larger stem heights and greater weights than all but 1:1:1 S-P-V. Jiffy Mix, 1:1:1 S-P-V, and Forestry Mix seedlings had average styroplug quality ratings that were excellent (3.9). The 1:1, 2:1, and 3:1 P-V mixes produced only fair (1.9 to 2.1) styroplugs, which were unacceptable for planting because roots were not developed enough to hold the plug together. All seedlings reached the suggested minimum quality index rating of 0.09, but Forestry Mix and 1:1:1 S-P-V were substantially higher than the others.

White spruce. Jiffy Mix and Forestry Mix seedlings had stem calipers and stem heights significantly larger than all others except those grown in 1:1:1 S-P-V (table 3). These three mixes also had the heaviest stem and root weights. There were no statistically significant differences between the treatments in shoot-root ratio. As with the red pine, Jiffy Mix, 1:1:1 S-P-V, and Forestry Mix styroplugs were rated excellent and plantable while the others were unacceptable. Only Jiffy Mix and Forestry Mix grew seedlings that attained the minimum quality index rating of 0.09; but 1:1:1 S-P-V was very close with a rating of 0.08, which was higher than the remaining three.

Conclusions

An acceptable seedling from the styroblock container must

Table 2.—*Mean values for 30-week red pine seedling parameters and ratings.*

Soil mix	Stem caliper	Stem height	Stem weight	Root weight	Shoot-root ratio	Plug quality rating	Quality index rating
	mm	*cm*	*g*	*g*			
Jiffy Mix	1.6ab[1]	8.9b	.921b	.191c	4.85a	3.9	0.11
1:1 P-V	1.5bc	8.0c	.857b	.175c	4.95a	2.1	.10
2:1 P-V	1.4c	7.9c	.832b	.164c	5.39a	1.9	.09
3:1 P-V	1.4c	7.8c	.795b	.167c	4.76a	2.1	.09
1:1:1 S-P-V	1.7a	9.5ab	1.258a	.239b	5.39a	3.9	.14
Forestry Mix	1.9d	9.7a	1.219a	.359a	3.51 b	3.9	.19

[1] For each parameter, means followed by a common letter do not differ significantly at the p=0.05 level.

Table 3.—*Mean values for 30-week white spruce seedling parameters and ratings.*

Soil mix	Stem caliper	Stem height	Stem weight	Root weight ratio	Shoot-root rating	Plug quality	Quality index rating
	mm	*cm*	*g*	*g*			
Jiffy Mix	2.0a[1]	18.1a	.978ab	.220a	4.45a	3.9	.09
1:1 P-V	1.7cd	15.0bc	.673c	.164b	4.25a	1.9	.07
2:1 P-V	1.6d	15.1be	.613c	.157b	3.91a	1.9	.06
3:1 P-V	1.6d	13.4b	.577c	.154b	3.76a	2.1	.06
1:11 S-P-V	1.ebc	16.3ac	.858b	.200a	4.31a	3.7	.08
Forestry Mix	1.9ab	17.9a	1.096a	.255c	4.29a	3.9	.10

[1] For each parameter, means followed by a common letter do not differ significantly at the p= 0.05 level.

be hardy enough to survive under field conditions and also must have a good enough styroplug to be planted. The styroplug quality rating is a measure of the plantability of a seedling. A favorable rating also indicates a well-developed root system, which is a necessity for survival after planting. The quality index rating incorporates both below-ground and above-ground measurements; so by using the two ratings, a complete evaluation of the seedling can be obtained.

It was found that the styroplug quality rating was a good indicator of the quality index rating of a seedling. All acceptable styroplug ratings except one also had quality index ratings that reached the suggested minimum. The exception had a rating of 0.08 instead of 0.09. The quality index ratings, however, were not as reliable in predicting styroplug quality with just over half the acceptable quality index ratings also having an acceptable styroplug quality rating.

This study demonstrated that the growing medium selected for rearing red pine and white spruce can greatly influence the quality of the resulting seedlings as measured by the previously described ratings. Following are salient conclusions inferred from the experimental results:

1. Mixes with sphagnum peat moss as a component gave better results for both species than those using only peat moss and vermiculite. This was in agreement with reports by other authors (*3, 4, 6*). Besides having a lower quality index rating than the others, the average seedling grown in 1:1, 2:1, and 3:1 peat moss and vermiculite was unacceptable when styroplug quality was used as the criterion.
2. For the rearing of red pine seedlings, the 1:1:1 sphagnum peat moss, peat moss, and vermiculite mix and Forestry Mix are recommended. Seedlings from these mixes reached acceptable minimum standards and also exceeded the other seedlings by a considerable margin in quality index ratings. Jiffy Mix also produced acceptable seedlings, but overall quality was lower than with the above two.
3. For the rearing of white spruce seedlings, Forestry Mix; Jiffy Mix; and the 1:1:1 sphagnum peat moss, peat moss, and vermiculite mix are recommended. These three mixes produced seedlings with excellent styroplug quality ratings and with the highest quality index ratings.

Economics also plays a role in the choice of a growing medium. The cost varies from one mix to another and preparation time must be included in the cost of the noncommercial mixes. However, the final crop of seedlings must be acceptable for outplanting or any cost savings in growing medium will be nullified.

Although this study used the seedling quality index rating suggested by Roller (*5*), further research needs to be done to establish a minimum standard rating for red pine and white spruce seedlings. Another alternative could be the development of a different index to measure overall seedling quality. Even with the recognized limitations of the ratings and measurements used, the results of this study can be of immediate and practical value in the rearing of containerized red pine and white spruce tree seedlings.

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