GROWTH OF OUTPLANTED NORTHERN RED OAK NURSERY STOCK RELATED TO SHOOT CHARACTERISTICS IN THE SEEDBED

Best growth was observed on northern red oak seedlings that maintained healthy green leaves into the second week of October, had relatively large leaf areas, and made three flushes of growth in the seedbed.

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First-year northern red oak (*Quercus rubra* L.) seedlings in the seedbed exhibit wide tree-to-tree and year-to-year variation in autumn shoot characteristics. These variations are probably the result of genetic, cultural, and environmental factors. Identification of fall shoot characteristics that are indicative of superior seedling vigor could aid in evaluating cultural practices and in selecting trees with a potential for rapid early growth.

This study investigated the relationship of autumn leaf color and retention, leaf area, and number of growth flushes to seedling vigor when planted the following spring.

Methods

Sixty northern red oak seedlings located in a 3- by 4-foot section of nursery bed were randomly selected and tagged. Seed, from a local source, had been planted the previous May. On September 24, 1974, the number of growth flushes and the length and width of each leaf on trees were measured. The relationship of leaf area to leaf length and width was determined from sample leaves as follows: Leaf area, cm^2 = 2.63 + .00523 (leaf length, mm x leaf width, mm), r = .987**

On October 8, 1974, the color of the upper mature foliage of each tree was classified into five broad but distinctive color classes as follows: (1) green, (2) reddish-green, (3) yellow-green (all gradations of yellowish-green to greenish-yellow), (4) leaf tips red (if leaf apex plus more than one-fourth of the leaf was red colored), and (5) red-brown (all gradations between red and brown).

On October 28, the same 60 study trees were reclassified into one of three foliage color classes: (1) red (including greenish-red and reddish-purple), (2) reddish-brown, and (3) brown. On November 6, 10 study trees appeared to retain more than one-half their summer foliage while the remaining trees were largely barren. The former were classified "leaf retainers" and the latter "non-retainers."

All trees were lifted April 8, 1975, root pruned to 6 inches, weighed, and immediately planted in coarse vermiculite in 1-quart milk cartons. The pruned-off roots of "leaf retainers" and "non-retainers" were kept and the total non-structural carbohydrate (TNC) of each group determined (*6*).

Seedlings were grown 30 days in a greenhouse, harvested, and the amount of new shoots and roots determined. Growth data were subjected to least squares analysis of variance. Simple correlation coefficients between certain variables were calculated.

Results

Fall leaf coloration and other shoot characteristics of northern red oak nursery seedlings were significantly related to seedling vigor the next spring. Seedlings of "green" class foliage on October 8, 1974, grew more new shoots (leaves and stems) when planted April 8, 1975, than seedlings of the other foliage color classes (table 1). Also, "green" and "reddish-green" trees tended to form more new roots than "red-brown" trees.

When lifted April 8, seedlings that had been classed "green" the previous fall on October 8 were 2.3 times heavier than the "red-brown" seedlings (table 1). This suggests that early leaf senescence leads to early cessation of dry matter accumulation.

The general progression in autumn leaf coloration was from green to red to brown, with purple hues and mottling of colors present during transition stages. The green to red transition often included the "red tipped" stage described above. In a few trees, yellow hues predominated during the transition from green to brown coloration.

Table 1.—*Seedling weight when planted in April and amount of new growth at 30 days of northern red oak seedlings that had been rated as to foliage color the previous fall*

	Foliage Color Class October 8[1]				
	Green	Reddish-Green	Yellow-Green	Leaf Tips Red	Red-Brown
When planted, April 8					
Seedling green weight, g	9.65a	8.77ab	7.00b	6.92b	4.26c
When harvested, May 9					
Leaves, green weight, g	2.90a	2.57b	2.03bc	1.83c	1.07d
Leaves, no.	9.2a	7.3b	8.6a	6.2b	3.4c
Stems, green weight, g	0.55a	0.34b	0.41ab	0.26bc	0.11c
Roots, no. [2]	6.2	8.4	3.8	5.1	2.5
Root length, cm[2]	33	51	17	32	13
Days to bud break, no.	6.8	6.5	6.0	7.2	7.9

[1] Means not followed by a letter or followed by similar letters do not differ at the 5 percent level, LSD test, n varied from 6 to 21 trees per class.
[2] F-value in the statistical analysis significant at the 10-percent level.

On October 28, 1974, the same trees were reclassified as either red, reddish-brown, or brown foliage color. The next spring, new shoot growth was similar for the three classes, but new root growth of "red" class trees tended to be less than that of the other two classes. Apparently foliage color at this later date in the fall was not very indicative of seedling vigor.

On November 6, 17 percent of the study trees were "leaf retainers" and the remainder "non-retainers." When planted, "leaf retainers" weighed 22 percent less and had 25 percent fewer new leaves when harvester than "non-retainers." The poor leaf development of "leaf retainers" was not due to a low proportion of root carbohydrates as the TNC of pruned roots of both groups was near 26 percent The amount of new root growth was also similar for the two groups. The "leaf retainers" of November 6 were randomly distributed between the foliage color classes of October 8.

The total leaf area of trees in September was correlated with planted weight in April, and both of these variables were correlated with the amount of new shoot and root growth (table 2). The correlation coefficients indicate that the amount of new spring growth was more closely associated with planted weight than with September leaf area. Neither of these two variables was significantly correlated with days to bud break, however. Positive correlation between planted weight and initial growth has been reported in other studies (*1, 3, 4*).

Trees that made three growth flushes in the seedbed grew more new leaves and stems when outplanted than trees with one growth flush (table 3). Three-flush trees also had the largest fall leaf area. However, growth of new roots and days to bud break were similar for trees with one, two, and three growth flushes.

Yearly variations in fall weather will alter the rate of change in leaf color and time of leaf fall. In this study, the daily mean temperatures for the period September 23 to October 11, 1974, averaged nearly 8° F below normal, and several earlier-than-normal frosts occurred. Leaf fall was about 3 weeks earlier than that noted in a previous study (*4*). Mild fall weather seems to promote the maintenance of green leaves on seedlings into November.

Table 2.—*Correlation of seedling leaf area on September 24, 1974, and planted green weight on April 8, 1975, with various aspects of new growth after planting*

	Variables	
	Leaf Area, September 24	Planted Weight, April 8
	(r)	(r)
Planted weight, April 8, g	.573 **[1]	—
New leaves green weight, g	.475 **	.867 **
New leaves, no.	.285 *	.522 **
New stems green weight, g	.373 **	.690 **
New roots, no.	.283 *	.470 **
Length new roots, cm	.307 *	.378 **
Days to bud break, no.	-.017 NS	-.243 NS

[1] Significance levels of r-values indicated as follows: ** = 1 percent, * = 5 percent, and NS = not significant.

Table 3.—*Fall growth, planted weight, and new spring growth of northern red oak seedlings with one, two, and three first-season growth flushes*

	Seedling	Growth	Flushes, no.[1]	
	1	2	3	P(F)[2]
When selected, September 24				
Leaf area, em'	137a	147a	190b	.016
Leaves, no.	4.9a	6.76	10.1c	.001
When planted, April 8				
Seedling green weight, g	6.27	7.24	8.44	.153
When harvested, May 9				
Leaves, no.	4.3a	7.0b	9.5c	.001
Leaves, green weight, g	1.67	2.08	2.49	.079
Stems, green weight, g	0.22a	0.34ab	0.436	.50
New roots, no.	5.23	5.02	5.40	.963
Length new roots, cm	31.3	27.5	29.1	.929
Days to bud break, no.	6.2	7.2	7.3	.517

[1] Number of trees with 1, 2, and 3 flushes was 16, 29, and 15, respectively.
[2] Significance level of F in least-squares analysis of variance. If F significant at .050 or less, then mean differences (LSD at 5-percent level) are indicated by different letters.

The planted weight of seedlings averaged 7.3 gin this study. Farmer (*2*) strikingly demonstrated that production of 1-0 red oak nursery stock of 50 to 60 grams per tree is possible under intensive culture. The problem of slow early growth of planted northern red oak seedlings (*5*) may be partly overcome by use of large, vigorous nursery stock.

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