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HEIGHT GROWTH AND FOLIAGE COLOR IN A SCOTCH PINE PROVENANCE STUDY IN NORTHERN MICHIGAN

Abstract.—A Scotch pine provenance study conducted in northern Michigan revealed important differences in height growth and foliage color among seedlings from 83 European sources. Seed from southern European sources produced seedlings with the best fall foliage coloration. Height growth was fastest among seedlings from sources with latitudes like that of the Michigan planting site.

One of the first studies of racial variation in forest trees was conducted on Scotch pine (*Pinus sylvestris* L.) by DeVelmorin (*1862*). His plantings at Les Barres, France, proved that seedlings obtained from different countries varied in several important growth characteristics. Researchers did not fully appreciate the importance of this finding until they discovered that Scotch pine seed from certain geographic regions produced crooked, slow-growing, and virtually worthless trees when planted in the United States; whereas seed from other areas produced more desirable trees.

To determine the best region or regions from which Scotch pine seed should be obtained for plantings in the North Central Region of the United States, a provenance study was established in northern Michigan in 1958. This report describes the results after 5 growing seasons.

Study Methods

Seed was collected from natural stands in 18 European countries. Seed trees within each stand were spaced far enough apart so that the chance of progeny from different trees sharing a common pollen parent was remote. One hundred six seed sources of Scotch pine were collected, and

Table 1.—*Data on origin of seed sources.*

Number	Country	North Latitude	Longitude	Elevation
				Meters
201	Norway	60.5	3.2 E	33
202	Germany	53.0	10.6 E	100
203	Germany	48.2	8.3 E	—
206	Germany	50.2	8.8 E	—
208	Germany	50.6	9.8 E	—
209	Germany	50.3	12.2 E	600
210	Germany	53.2	14.3 E	—
211	East Prussia	53.8	12.2 E	—
213	Turkey	40.5	32.7 E	1,600
218	Spain	40.3	5.2 W	1,200
219	Spain	40.8	4.0 W	1,600
220	Turkey	40.0	31.3 E	1,500
221	Turkey	40.5	32.7 E	1,600
222	Sweden	60.2	15.0 E	250
223	Latvia	57.5	25.8 E	—
224	Latvia	57.7	26.3 E	—
227	Siberia	54.0	94.0 E	200
228	Finland	60.4	25.4 E	40
229	Finland	65.2	25.5 E	10
230	Finland	60.5	22.4 E	45
233	Finland	61.5	26.0 E	—
234	Russia	56.0	95.0 E	200
235	France	48.2	9.2 E	720
241	France	49.1	7.4 E	250
242	Yugoslavia	43.9	19.4 E	1,000
243	Greece	41.5	24.3 E	1,800
245	Spain	40.7	4.2 W	1,500
246	Spain	41.8	2.8 W	1,200
247	Spain	41.8	2.7 W	1,100
248	Germany	48.5	9.8 E	—
249	Austria	[1]	[1]	400
250	Germany	49.4	7.6 E	400
251	Germany	49.1	8.1 E	150
253	Germany	49.1	7.8 E	400
254	Russia	60.8	131.6 E	750
255	Russia	52.4	117.7 E	600
256	Russia	56.7	96.3 E	350
257	Russia	56.8	65.0 E	150
258	Russia	58.8	60.8 E	50
263	Russia	41.8	43.4 E	1,120
265	Scotland	57.1	4.9 W	200
266	Scotland	57.2	3.7 W	250
267	Scotland	57.2	4.8 W	300
268	Scotland	57.2	3.8 W	200
271	Greece	41.5	24.3 E	1,550
273	Norway	59.7	9.5 E	200
274	Norway	60.3	9.9 E	200
275	Norway	59.8	11.6 E	220

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Table 1—Continued

Number	Country	North Latitude	Longitude	Elevation
				Meters
276	Norway	59.8	11.5 E	220
305	Czechoslovakia	49.0	14.7 E	400
306	Czechoslovakia	49.2	14.0 E	450
307	Czechoslovakia	49.9	17.9 E	250
308	Czechoslovakia	50.2	15.5 E	200
309	Czechoslovakia	49.8	13.3 E	680
310	Czechoslovakia	48.7	14.9 E	550
311	Czechoslovakia	50.5	.6 E	300
312	Czechoslovakia	50.9	15.8 E	600
315	Czechoslovakia	49.1	16.2 E	300
316	France	45.1	3.5 E	1,000
317*	France	53.7	20.5 E	200
318**	France	51.2	5.5 E	—
319	Austria	—	—	500
521	Sweden	59.8	18.0 E	20
522	Sweden	60.9	16.5 E	225
523	Sweden	61.3	15.9 E	270
524	Sweden	61.3	17.9 E	30
525	Germany	50.4	12.2 E	465
526	Germany	50.4	12.2 E	510
527	Germany	50.9	13.7 E	540
530	Belgium	50.0	5.0 E	330
541	Sweden	57.7	15.5 E	150
542	Sweden	58.8	14.3 E	125
543	Sweden	59.9	12.9 E	200
544	Sweden	60.4	14.9 E	250
545	Sweden	60.4	12.9 E	250
546	Sweden	60.9	13.4 E	450
550	Sweden	55.9	14.1 E	20
551	Greece	41.3	23.2 E	—
552	Hungary	47.3	17.8 E	250
553	Hungary	47.7	16.6 E	328

[1] Commercial seedlot.

* Source 317 var. *rigensis* (Kluger).

**Source 318 "Belgium Long-needle" (Raeymaekers).

83 sources were included in this outplanting (table 1). Stock was grown in a nursery at East Lansing, Mich., and distributed for outplanting as 2-0 stock in the spring of 1961.

Eight replications of four-tree-line plots in a randomized complete block design were planted near Houghton, Mich. (Lat. 47° 20′ N. Long. 88° 50′ W). An 8-x-8-foot spacing was used, and trees were planted in an old field furrowed in both directions to reduce early sod competition.

Survival was checked in the fall of 1961, and replacements were made with 3-0 stock in the spring of 1962.

The data for this report were collected in November 1963, and represented 5 complete growing seasons—two in the nursery and three in the field. Only total height, survival, and foliage color were recorded although some observations were made on needle length and diameter. Analysis of variance was used to test differences in tree height among sources. Missing plot values were supplied using the technique described by Cochran and Cox (*1950*).

Results and Discussion

Highly significant differences were found in height growth between seed sources. No differences were observed between blocks. The tallest seedlings were from sources similar in latitude to the outplanting site (Lat. 47° N), and the shortest trees were from sources between 55° and 65° N latitude. Height growth also tended to decrease in seedlings from the southern sources (figs. 1 and 2).

Figure 1.—Latitude of seed source plotted over height of seedlings after 3 growing seasons in field.

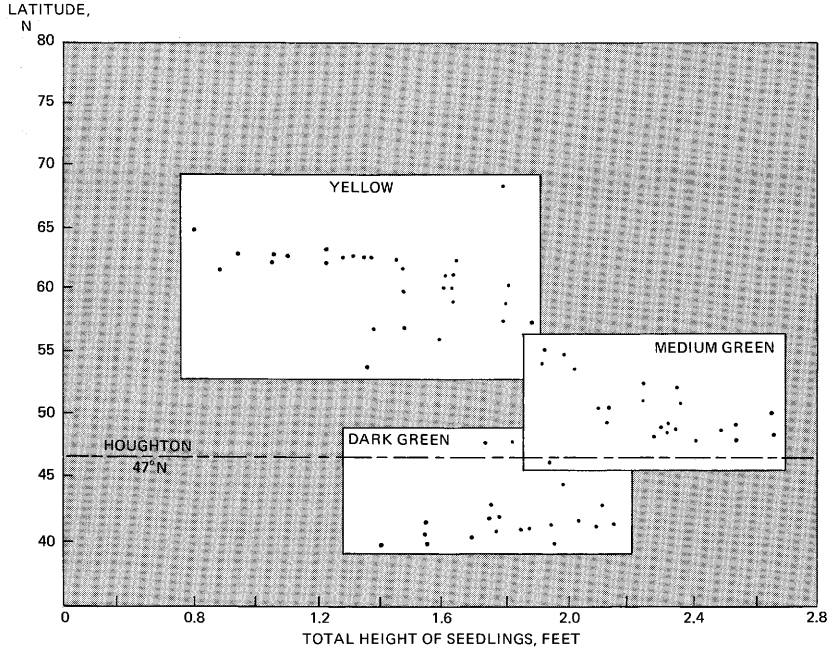
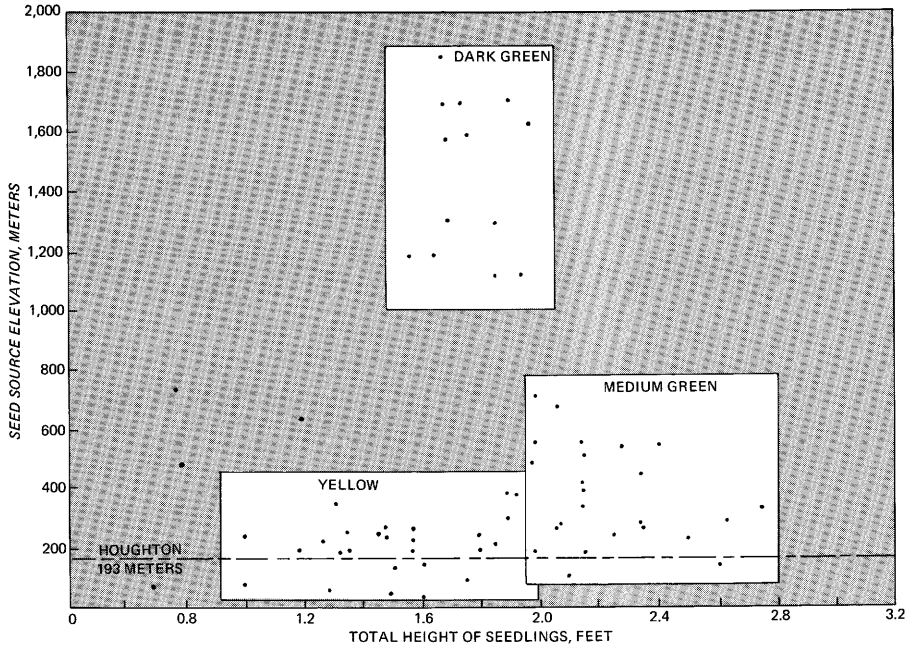


Figure 2.—Altitude of seed source above sea level plotted over height of seedlings after 3 growing seasons in field.



Fall foliage color also appeared to follow a definite geographic pattern. The darkest green foliage was found on seedlings from sources south of latitude 45° N, and the yellowest foliage was found on seedlings from sources north of latitude 55° N (fig. 1). Elevation of the seed source was also related to foliage color. The darkest foliage was found on seedlings from sources on the highest elevations (above 1,000 meters), and the yellowest foliage was found on seedlings from sources on the lower elevations (below 300 meters) (fig. 2).

Other morphological features observed were:

- Seedlings from sources 220 (Turkey) and 263 (Russia) had longer needles than seedlings from the other sources.
- Seedlings from source 316 (France) had more lateral branches per whorl than seedlings from the other sources.
- Seedlings from source 206 (Germany) had fine-textured needles similar to white pine and unlike the characteristic thick needles of Scotch pine.

- Seedlings from sources 241 (France), 242 (Yugoslavia), and 553 (Hungary) displayed some prolepsis (late-season development of lateral buds at the base of the terminal bud).

With the exception of slight needle damage to seedlings from source 224 (Latvia), no insect damage was observed in this outplanting area. Snow damage causing deformed and prostrate main stems is quite prevalent throughout the plantation, probably because seedlings were planted in deep furrows and the accumulations of snow are heavy in this area.

Our results seem to reinforce earlier observations about growth rate and foliar color of Scotch pine from various geographic seed sources. Wright *et al* (*1966*) found that trees from the extreme northern provenances were shortest; trees from central Europe were tallest; trees from western Europe were a darker blue; and trees from Siberia had the yellowest foliage.

Several writers (*Wright and Bull, 1963; Wright and Baldwin, 1957; Wright, et al., 1966*) have suggested that Scotch pine is composed of a number of distinct ecotypes. However, Langlet (*1959*) challenged this conclusion. He suggested that the data presented by Wright and Baldwin indicate that variability is continuous and that geographic ecotypes are not present. Our results seem to agree more closely with the clinal variation concept because no well defined breaks in height or foliage color separate one population from another.

Conclusions

Final judgments about mature tree form and other features such as wood quality of trees from the various sources will be made later. However, from what we have learned from this study so far, we can now make some tentative recommendations. Persons interested in growing Scotch pine for sawtimber in the Upper Lake States area and primarily interested in fast growth rates probably should select seed from central European sources.

If the future crop is to be Christmas trees and fall foliage color is the important consideration, then seed from southern European sources should be used. Source 316 (France) should be investigated further for this purpose because trees from this source have most of the characteristics desired in a good Christmas tree—dark green foliage late in the fall, moderately fast growth rate, and more lateral branches per whorl than trees from other sources.

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