PERFORMANCE OF FIFTY-FIVE SEEDLOTS OF SCOTCH PINE AT TWO LOCATIONS IN NEW YORK

L. S. Hamilton, C. E. Heit, E. J. Eliason, and D. Carlson[1]

During the past two decades C. E. Heit has been obtaining known seed sources of Scotch pine and observing their performance as 1- and 2-year seedlings and S- and 4-year transplants. The European sources were secured directly from authorized foresters, seed collectors, or government stations, so that source data would be accurate and reliable. Certain sources which have become recognized as naturalized American "strains" have also been included in Heit's tests. Reports of this work first appeared in the New York Christmas Tree Growers' Association Bulletin in July 1963 and in the February 1964 American Christmas Tree Growers' Journal (4)., Recently a comprehensive summary of all his work to date has appeared in the American Nurseryman (5). Some of the same sources used in this present study were involved in Heit's report.

Fifty-five of these seedlots were supplied by Heit as 2-0 stock and planted out in 1960, 1961, and 1962 by E. J. Eliason at the State Conservation Department Tree Nursery at Saratoga Springs, New York, and by L. S. Hamilton at the Cornell Biological Field Station at Bridgeport, New York. The list of seed sources tested at both sites is given in Table 1. Only 44 different seed sources are represented; in several cases collections were made in two different years from the same area.

Twenty-five to thirty trees of each seedlot were planted in rows in separate blocks each year at each location. The Saratoga Nursery site is on a sandy outwash plain on the southeastern fringe of the Adirondacks at an elevation of about 550 feet. The growing season averages about 148 days and the annual precipitation averages 34 inches. The soil is a well-drained Merrimac fine sand, pH 5.6-6.2. The Cornell Biological Field Station is located on the south shore of Oneida Lake in Central New York at an elevation of 380 feet. It averages about 180 days in the growing season and the annual precipitation is about 46 inches. The soil is a somewhat poorly drained, lake-laid, Fulton silty clay loam with a pH of 5.8- 6.2.

The trees were released mechanically from vegetative competition as required, and following some mouse damage and a few losses at the Bridgeport location, rodent control measures were applied. The following measurements were

[1]Respectively: Professor of Conservation, Cornell University, Ithaca, New York; Seed Technologist, New York State Agricultural Experiment Station, Geneva, N. Y.; Head of Forest Research Unit, New York State Conservation Department, Albany, N. Y.; Forester, Forest Research Unit, New York State Conservation Department, Albany, N. Y. Financial support for the Cornell portion of this study was from U. S. Department of Agriculture funds administered under the Hatch and Regional NE-27 projects.

Table 1. Seed Sources Tested

Lot Number	Country	Province, Area, Locality, etc.	Elevation (feet)
13361	Austria	(Lower)	
16982	"	Tyrol Mountains	3600
11422	Belgium	Antwerp Province Campiegne	
14987	"	Campagine	300
16291	France	Auvergne - Casadeennee	4000
16292	"	Auvergne - DePradelles	3000
16293	"	Auvergne - DeLaMargaride	4000
16294	"	Auvergne - LaLoire River Valley	1300-2000
16295	"	Auvergne - Lourdes	2000-3000
16438	"		
12275	"	Grocal	1000-1500
12276	"	Pyrenees Orientale-Canton Mountain	4700
12277	"	Orane-Canton, LeMassegros	3000
12278	"	Jacreste Canton, St. Germain deCalberte	1700-1800
17870	Germany	Burgebrach	
18181	" (Southern)	Altdorf near Nuremberg (Northern Bavaria)	700
18182	" "	Schrobenhausen near Augsberg, Bavaria	1000
13531	Greece (1961, 62)*	Kozani District - Kataphygio Forest	
17203	" (1961, 62)	Oriental Macedonia, Laila, Serres	5300
41	Scotland	Tentsmuir, Fiflahire 56°20'N, 2°55'W	
56/349	"	Lael Forest 57°40'N, 5°10'W	
56/579	"	Glen Loy Forest 56°50'N, 5°20'W	
14706	"	Rosarie Forest, Banffshire - Comp. #104 & 195	750
14284	"		
17207	"	Spey Valley Morayshire	
321	Spain (1960, 61)	Burgos Province	5600
322	" (1960, 62)	Burgos Province	3000
323	"	Cuenca Province	4600
324	" (1960, 62)	Cuenca Province	5600
325	"	Guadalajara Province	4600-4900
326	" (1960, 62)	Guadalajara Province	5600-5900
327	"	Soria Province	5300
328	" (1960, 62)	Soria Province	3900
15973	"	Segovia Province, North Exposure, Sierra de Guadarrama	4300
19589	Sweden	Southeast (Riga)	
12508	Turkey (1961, 62)	Ankara Province, Kisilcahaman	5000
12509	" (1961, 62)	Eskisehir Province, Catacik	4300-5000
1656	Yugoslavia		
12507	Nyebranch Strain U.S.	Nyebranch Nursery, Porter, Pennsylvania	
13527	Pain Creek U.S.	Single Tree Selection, N.W. Pennsylvania, Paint Creek Nurseries, Shippenville, Penn.	
13558	Nelson King Strain U.S.	1958 Crop - Raymond Nelson Nursery, Dubois, Penn.	
14721	Abell's Blue Green U.S.	1958 Crop - Genesee Valley Nursery, Belmont, N.Y.	
11656	Lewis Co. U.S.	Lewis Co., New York **	
	Boonville (1960, 61) U.S.	Boonville, N.Y. ***	1200

* Dates in parentheses indicate different crop years collected and tested.

** Collected by Schumacher from what he reported as Russian seed planted in 1908 in Lewis County.

***This "famous" domestic source is described by E. J. Eliason in "The Boonville Scotch Pine Story". New York Christmas Tree Growers' Association Bulletin 2(3) p. 4. Oct. 1964.

made in December and January 1966: current height growth (in feet and tenths), height growth of last two years (in feet and tenths), stem straightness, number of branches in the upper three whorls, branch angle of average branch in the second whorl from the top (in degrees), presence of lammas shoots, number of years of needle retention, needle length (in inches and tenths) (needle picked from center of uppermost internode on main stem, south side). Winter foliage color was measured in January 1967 using the Munsell notation (2) and selecting a needle from the center of the uppermost internode on the main stem, south side.

Heit (5) has shown differences in transplant beds between many of these seed sources at one site at Geneva, New York, for such characteristics as winter foliage color, rate of height growth, and needle length. Hamilton and Frommer (3), for 20- to 25-year-old field planting, not only showed differences between seed sources for height growth, diameter growth, branch angle, number of branches per whorl, needle length, winter foliage color, and stem form at the same site, but also found differences in height growth, diameter growth, needle length, and number of branches per whorl for progeny from the same Scotch pine parent between sites. Lammas shoot production has been shown to vary not only by year (climate) and location, but by seed source (6).

The present study summarizes the main findings following measurements made in 1966 and 1967 on the field plantings which were at that time 6, 5, and 4 years in the field, after being set out as two-year seedlings. The Saratoga Springs plantings were made with two replicates of each seed source in 6'x6' rows. The Bridgeport plantings were single rows of each seedlot at a 6'x8' spacing. These plantings were primarily intended for demonstration use, were not randomized in a sound experimental design, and therefore statistical analysis is not attempted. The evident differences between seed sources and between sites are reported for each of the measured characteristics.

HEIGHT GROWTH

Height growth was almost consistently greater for each seedlot at the Saratoga Springs location, but not significantly so, according to the sign test. Mean current height growth ranged from a low of 0.6 feet for France 12276 at Bridgeport to a high of 3.3 feet for Belgium 14987 at Saratoga. In general, the Spanish sources grew the slowest at both locations and the German sources grew the fastest. Specific sources showing the slowest height growth at each location are ranked as follows:

Bridgeport			Saratoga		
Rank	Seedlot	Mean ht. (ft.)	Rank	Seedlot	Mean ht. (ft.)
1	France 12276	0.6	1	Turkey 12508 (62)	0.7
2	Spain 326 (62)	0.7	2	Spain 322 (62)	0.8
2	Spain 324 (62)	0.7	2	Spain 324 (62)	0.8
2	Turkey 12508 (62)	0.7	2	Spain 328 (62)	0.8
5	Spain 322 (62)	0.8	2	France 12276	0.8
5	Spain 328 (62)	0.8	2	Spain 326 (62)	0.8
			2	Greece 17203 (62)	0.8

These were followed in general by the other Spanish and most French seedlots and then by the Turkish sources and such specific sources as Southeast Sweden and Paint Creek. Specific sources showing the fastest current height growth ranked as follows:

Bridgeport			Saratoga		
Rank	Seedlot	Mean ht.(ft.)	Rank	Seedlot	Mean ht.(ft.)
1	Belgium 14987	2.9	1	Belgium	3.3
2	Lower Austria 13361	2.5	2	Lower Austria 13361	2.9
3	Germany 17870	2.4	2	Germany 18181	2.9
4	Germany 18181	2.1	4	Germany 17870	2.7
4	Scotland 56/579	2.1	4	Boonville (60)	2.7
6	Germany 18182	2.0	6	Germany 18182	2.6
6	Boonville (60)	2.0	7	Yugoslavia 1656	2.4
6	England 41	2.0			

These were followed in general by the Scottish and English sources. The pattern of two-year height growth was almost identical and is not recorded here.

NEEDLE LENGTH

As with height growth, the needle lengths were generally longer for the same seedlot at Saratoga Springs compared with Bridgeport, though this difference did not prove significant by the sign test.

Needle length varied from less than 1 inch to over 3 inches. In general, the shortest needles were produced by the Spanish and French sources and the longest needles by the Belgian and Lower Austrian and German sources. Specific sources showing the shortest needles in each location follow:

Bridgeport			Saratoga		
Rank	Seedlot	Mean length (in.)	Rank	Seedlot	Mean length (in.)
1	325 Spain	.9	1	325 Spain	1.2
2	322 Spain 1960	1.0	1	326 Spain	1.2
3	324 Spain 1960	1.1	1	17203 Greece 1962	1.2
3	328 Spain 1960	1.1	4	322 Spain 1960	1.3
3	16292 France	1.1	4	328 Spain 1962	1.3
6	321 Spain 1961	1.2	4	323 Spain 1961	1.3
6	322 Spain 1962	1.2	4	12276 France	1.3
			4	12508 Turkey 1962	1.3

Those sources having the longest needles, generally considered less desirable for Christmas tree purposes, were as follows:

Bridgeport			Saratoga		
Rank	Seedlot	Mean length (in.)	Rank	Seedlot	Mean length (in.)
1	11422 Belgium	2.6	1	14987 Belgium	2.7
1	13361 Lower Austria	2.6	2	18181 Germany	2.6
3	18181 Germany	2.5	2	17870 Germany	2.6
4	12507 Nyebranch	2.5	4	13361 Lower Austria	2.5
5	56/349 Scotland	2.4	5	18182 Germany	2.4
6	14987 Belgium	2.4			
7	Boonville 1960	2.4			

WINTER COLOR OF FOLIAGE

According to the Munsell color scale, needle samples taken ranged from a high of 35.8 (5.0 GY) to a low of 28.4 (7.5 Y). Means for species at the two locations showed a narrower range. Very desirable color was deemed to be above 2.5 GY. At Bridgeport, the January needle color was above 2.5 GY on the Munsell scale for the following seed sources (ranked in order of greenness): 322 Spain (1962), 323 Spain (1961), 321 Spain (1961), 326 Spain (1960), 328 Spain (1962), 326 Spain (1962), 16291 France, 13558 Nelson-King, 12276 France, and 17203 Greece (1961). At the Saratoga Springs location all of the following seedlots gave January readings above 2.5 GY Munsell (ranked in order): 12278 France, 326 Spain (1962), 322 Spain (1962), 324 Spain (1962), 322 Spain (1960), 325 Spain, 323 Spain (1961), 12276 France; 326 Spain (1960), 12275 France, 12277 France, 328 Spain (1962), 17203 Greece (1961), 321 Spain (1961), 327 Spain, and 324 Spain (1960). The good color generally attributed to Spanish sources is amply expressed in these tests at both locations. No winter needle burning was noted on the Spanish sources, though it has been rumored in areas of Michigan and Wisconsin. Measurements were made by the same observers using a grey background and a standard 100-watt incandescent lamp for illumination, so that the larger number of seedlots showing good color at Saratoga Springs may represent a site influence on needle color. This would need further testing with better experimental design.

Seedlots having January foliage color with a yellow hue, 7.5 Y to 10.0 Y at both locations were: 19589 Southeastern Sweden; 18181 Germany; 13361 Lower Austria; 1656 Yugoslavia; 11656 Lewis County, New York; and 14987 Belgium. The Southeast Swedish source ranked much worse than all of the others, and this characteristic of all of the Scandinavian sources is well known to Christmas tree growers for whom winter color is an important characteristic.

NEEDLE RETENTION

The amount of stem and branch bearing live foliage contributes much to the quality of Scotch pine for Christmas trees. In some unusual years in certain locations, in apparent response to climatic conditions, plantations have retained only the current year's needles, and this has resulted in substantial loss of sales in ready - for - market trees. In normal years there are still differences in needle retention between trees of different seed sources, or even between individuals. In winter, Scotch pines usually average 2 years of needles. Outstanding at both locations in this study was 16292 France which averaged 2.8 years. Other outstanding sources at both locations were 16293 France, 16438 France, and

56/349 Scotland. In general, the French seedlots were all good performers in this respect. Needle retention seemed better this year at the Saratoga Springs location than at the Bridgeport site. Thirty-five seedlots held needles better at the former site while only 11 showed better needleholding at the latter site. Differences between sites were nonsignificant, however, by the sign test. None of the seedlots showed very poor performance for this characteristic during this year.

STEM STRAIGHTNESS

Scotch pine has been fairly notorious as a Christmas tree for having stems which are not truly straight and are thus difficult to mount properly in a home-owner's tree stand. Pistol butt, crook, and sweep are very common. A measuring pole was held beside each tree, and this rigorous standard was used to classify the tree as absolutely straight or not. Percentages of straight trees for each seedlot were amazingly low. Eighteen of the 55 seedlots produced no absolutely straight trees at either location. The best seedlots were: 12276 France, 12275 France, 13531 Greece, 56/579 Scotland. However, the authors agree essentially with Heit (5) that one cannot identify seed sources as a single factor responsible for stem straightness in these young trees. Environmental factors such as rodent damage, improper planting, snow loading and ice damage, vegetative smothering, and windblowing are so common and must exert a major effect masking most genetic control.

NUMBER OF BRANCHES PER WHORL

The number of branches at each node in unsheared trees can affect Christmas tree quality. Means for the last three whorls were determined for each seedlot. These varied from a low of 9 branches in three whorls to a high of 26. A remarkable difference between locations showed here, with 49 of the 55 sources having a greater number of branches at Saratoga Springs than at Bridgeport. This difference by the sign test is highly significant. Sources at each location showing the greatest number of branches per three whorls are ranked as follows:

Bridgeport			Saratoga		
Rank	Seedlot	Branches/3 whorls	Rank	Seedlot	Branches/3 whorls
1	14987 Belgium	18.5	1	14987 Belgium	26.1
1	1656 Yugoslavia	18.5	2	18182 Germany	24.3
3	Boonville	17.9	3	Boonville	24.1
4	13361 Lower Austria	17.3	4	16292 France	23.5
5	11422 Belgium	16.0	5	18181 Germany	23.1
5	18182 Germany	16.0	5	17870 Germany	23.1
7	17870 Germany	15.8	7	16293 France	22.5
8	18181 Germany	15.2	8	1656 Yugoslavia	22.0

Sources at each location showing the least number of branches in the last three whorls (averaging less than 4 branches at a node) are as follows:

Bridgeport			Saratoga		
Rank	Seedlot	Branches/3 whorls	Rank	Seedlot	Branches/3 whorls
1	326 Spain (1960)	9	1	324 Spain (1962)	10.8
1	328 Spain (1962)	9	2	12508 Turkey	11.5
1	324 Spain (1962)	9	2	17207 Scotland	11.5
1	12276 France	9	2	17203 Greece (1962)	11.5
5	12508 Turkey (1962)	10	2	12509 Turkey (1962)	11.5
5	326 Spain (1962)	10	6	322 Spain (1962)	11.6
7	322 Spain (1962)	11			
7	12509 Turkey (1962)	11			
7	323 Spain (1961)	11			
10	323 Spain (1960)	11.2			

In general for this characteristic, the German and Belgium sources perform best and the Spanish sources poorest. Tree density is also a function of internode length, however, perhaps primarily in unsheared trees. As already shown, under height growth, the Spanish sources are generally slowest and hence most compact, and the German and Belgian seedlots are the most open or "leggy." Shearing, of course, is used to modify both of these characteristics which contribute to tree density.

BRANCH ANGLE

The angle which the branches make with the stem has been shown to vary with seed source (3). While mean branch angle varied from a high of 85.5 degrees for 325 Spain at Bridgeport, to a low of 58 degrees for Nelson-King at Saratoga Springs, no pattern of consistency between locations nor for general seed source areas was evident. Spanish sources also showed up in the low branch angle group. No conclusions are suggested by the data.

LAMMAS SHOOTS

Production of lammas shoots was more common at Saratoga Springs than at Bridgeport, and the difference was significant according to the sign test applied. In the year of measurement (1966) nine seedlots showed some secondary growth at Bridgeport, while 23 seedlots at the other location had some lammassing. Highest percentage of this phenomenon occurred in the Boonville source at Saratoga, with 13 percent of the trees having this type of growth. Poorest sources in this respect were: 14706 Scotland, 17870 Germany, 12507 Nyebranch, and 18181 Germany. Bell (1) and Heit (5) have both mentioned sources from Scotland having this prediliction which leads to uneven density, stem crook, and forking, but which can be overcome through shearing.

SUMMARY

Some 55 known sources of Scotch pine were planted in two locations in New York in 1960, 1961, and 1962. Evaluations for Christmas tree purposes were made in 1966 and 1967. These included height growth, that is, slow or rapid growth rate, needle length, winter color of foliage, needle retention, stem straightness, number of branches per whorl, branch angle, and lammas shoots. The paper

discussed these factors in relation to special sources as well as general sources, such as: French, Spanish, German, and Turkey lots. The two planting sites are compared with some differences in the performance of the seedlots. Those growing Christmas trees may be aided in their selection of sources, choosing those which show the characteristics which they deem desirable and in order to minimize the amount of cultured work which they must put into meet the needs of their markets.

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DISCUSSION

GABRIEL - The trees that come from the far north country grow relatively slowly, don't they?

ELIASON - Yes.

GABRIEL - And they also don't need as much pruning, do they?

ELIASON - That's right. Balance and taper need to be corrected by pruning. These sources also have short needles.

GABRIEL - Now, why don't you educate the public to the desirability of golden hybrids and sell those yellow trees?

ELIASON - Yes, we have been working on that. But they don't go for the yellow tree. Evidently, they want a green tree even though they may paint it pink before they get it home. There was a lot of talk about this golden tree business, but they don't take to it. Apparently, the yellow color is associated with unhealthiness.

ANONYMOUS - If you cut trees earlier, color is better.

ELIASON - Yes, that's right. If you do this early, about the beginning of October, and put them in a shady place, the color is better. You should keep the sun off them as it fades the green color. Yes, if you have storage facilities you can do it.

ANONYMOUS - We had a whole lot of them grown at 50¢ apiece, took them to New York City, and sold them as Golden Pine for S5.00.

ELIASON - They got stuck!

ANONYMOUS - Really, isn't it very much in the nursery selection of the variety of Scotch pine production in New York, or is it more the Spanish, French, or Boonville?

ELIASON - We have seed orchards set up with the Boonville source because it has some outstanding timber trees. We have two large tree orchards of selected Boonville, from good trees, not because of color, but because of form. So as far as the nursery is concerned, officially we aren't growing Scotch pine for Christmas trees, but unofficially we are. We tell them what we have; some don't go for Christmas trees. Theoretically, the Christmas tree business is a thinning process -- removing some and leaving the rest to go for timber. It all depends on the individual. We don't make an issue of selling for Christmas trees purpose alone. If they use them for Christmas trees, we don't have much to do about it because we have no restriction on their use except you can't sell them as ornamental. One time we mixed up the yellow and the green ones. This was not popular with the Christmas-tree people. It was the idea that the green ones would make Christmas trees, and the yellow ones were for timber. These were slow growing, but made straighter stems.

McCORMACK - You mentioned mouse damage. Did you see any source preference on the part of the mice?

ELIASON - No, we did not. In the heavier grass --where the mice seemed to harbor -- there is where we got the trouble. I doubt if there was any preference there; at least, we did not have enough to bring that out. You need to have a uniform mouse situation, then you can see if sources make any difference.

ANONYMOUS - The only thing I would say-- I don't know anything about varieties of Scotch -- if you have Scotch and Austrian pine together, the mice always eat the Austrian first.

GABRIEL - Is there any difference in response to shearing among the various varieties?

ELIASON - There were not enough trees per lot to allow us to do this, so we let them all grow naturally. You can shear some if it is a uniform situation and you have lots of trees per lot. It's like the mice business -- first you must have a uniform platform to begin with, and with small numbers, it is very difficult to carry on any such study.