

WINTER FOLIAGE COLOR OF SCOTCH PINE¹

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The practice of raising Scotch pine (*Pinus silivestris*) for Christmas trees in Eastern U. S. has focused attention on needle color as related to origin of the seed. Trees that turn yellow in the autumn are undesirable as Christmas trees, while those that remain blue-green or dark green are favored. It has long been observed that trees grown from seed collected in the far north develop a golden foliage with the approach of winter. Certain sources from lower latitudes and from continental areas often have a pale yellow hue. The so-called maritime races usually retain a blue-green color the year round; others, chiefly from Southeastern Europe, may have a deep or dark green foliage.

Opportunity to observe this relation of foliage color to source of seed was presented by the extensive series of permanent plots of the International Union of Forest Research Organizations and other series maintained on the Fox and Vincent State Forests in Southwestern New Hampshire. Preliminary observations were made in seed and transplant beds, both at the Fox Forest and at the Saratoga Nursery, New York, from 1938 to 1941 and later in the plantations in the late winter of 1955. It is planned to check the latter during January 1956 because of conflicting results in some cases in the 1955 scoring. Conclusions are based chiefly on the International Union plots because of the greater number of sources represented with more replications of the same source on a uniform site.

Observations in Seedling Stage

The seeds received from the International Union in 1938 were planted in drills according to Union specifications. In the fall of that year when the seedlings had completed one growing season each plot was studied and rated for needle color in one of 5 classes as follows:

¹ This paper was not read at the Conference. It was written and is included in these Proceedings in response to the widespread interest in winter color apparent from the discussion that followed the previous paper.

Class A. Uniformly Purple. Norway, Sweden, Finland, Latvia, Esthonia. Ten Baltic coast sources.

Class B. Largely Purple. Southern Sweden, Finland, Holland, Germany, Poland, Roumania. Eight sources.

Class C. Varying Purple to Green. Far Northern Norway, Sweden, Finland, also Latvia, Germany, Poland, Hungary and Belgium. Seventeen sources.

Class D. Variable, Green to Slightly Purple. Southern Sweden, Central Germany, Poland, Czechoslovakia and Hungary. Twelve sources.

Class E. Uniformly Green. Netherlands, Czechoslovakia, Yugoslavia and Rhine Plain in Germany. Four sources.

The only distinct differences appear to be in the extremes. Baltic coastal origins were definitely purple and southern lowland origins green. The surprising result is that the far northern sources were mixed purple and green. All the intermediate classes showed a wide geographic distribution.

Descriptions of the Plantations

The 151 rectangular plots, averaging 170 trees per plot were established on the Vincent State Forest in Deering, N. H., in 1942 using 2-2 stock grown in the Fox Forest Nursery. The trees were 17 years old from seed at the time of the last observation. Forty-six geographic sources were represented. The site is a nearly level ridge top at an elevation of 1100 feet once used as a hay field and later for pasture. The soil is a Paxton loam showing cultivation for the first 6 inches. The most important feature of the profile is a compact layer varying from 16 inches below the surface on the hilltop to 30 inches or more on lower slopes. This nearly impermeable layer reduces the effect of drought by retaining precipitation above the layer; it also restricts root development to the upper soil layers, possibly resulting in more intense root competition than in soils enabling deeper root penetration. As far as can be determined from sampling in numerous parts of the plantations the soil is remarkably uniform in present structure and past history. There is a possibility, however, that some plots show needle color influenced by site conditions in addition to genetic response to climate.

All the plantations are now too old for best appraisal of foliage color. They are closed stands with the top of the crowns 10 to 35 feet high. Further more it is uncertain to what extent the coloring may change with age. Greater temperature ranges occur when the crowns reach to the ground with openings between the trees. The far northern sources with stunted growth now form frost pockets surrounded by taller trees and this may intensify the coloring of the small trees. In any case it is the color of trees when 5 to 8 feet high that is of practical interest to the Christmas tree grower.

Method of Evaluation of Older Plantations

The scoring of plots was purely subjective and descriptive. The foliage was examined on overcast winter days with snow on the ground but none on the tree crowns. A decision was based on the color of the majority of the trees without comparison with adjoining plots. Each plot was tallied on a special form with descriptive notes on needle color. This method has its limitations but at least the judging was done by one individual. Since the plots were identified by number only there was no temptation to pre-judge based on expectations of what the color should be. Upon analysis of the field notes the descriptions were classified into 7 groups. Of these the extremes of color were, of course, the easiest to classify.

Foliage Color of Seventeen-Year Scotch Pine, February 1955

The largest number of plots fell into the bluish green group (Class 2.), otherwise the distribution in the classes was quite equal. The geographic range within the intermediate classes was surprisingly large, indicating that the factors influencing color may be many and complex. High latitude appears to be definitely correlated with bright yellow or golden foliage but any latitude relationship is less clear with other shades. All plots classed as golden and two thirds of those classed as yellow or gold-tipped originated from places above 60° N. lat. whereas but two plots classed as yellow green and none classed as deep green or slightly blue-green came from above this latitude. The very blue and bluish green plots varied widely from nearly 65° to low latitudes.

The following classification represents an approximate grouping of the sources available, listed in table 1, based on one year's evaluation. It thus makes no claim to completeness or that all geographic areas in the countries named fall in the same class. It simply represents the behavior of certain isolated and random sources.

Class 1. Pronounced Blue Green (Glaucous) Foliage (23 plots). Scotland, Czechoslovakia (High Tatra), Belgium, Germany, (Hessen, Saxony), Estonia, Sweden. Latitude Range: 51° - 64°. These sources are mostly near the seacoast or on lowlands in high latitudes or mountain areas at lower latitudes.

Class 2. Bluish Green (Sometimes Gold-Tipped) (47 plots). These may be separated into two subclasses: (A) Northern Maritime Sources (13 plots) Norway, Sweden, Finland, Latvia. Latitude Range 57°-61°. These commonly had gold-tipped needles. (B) Continental Sources (34 plots). Sweden, Germany Poland, Hungary, Netherlands, Roumania. Latitude Range: 46°- 53°

Class 3. Slightly Blue Green Foliage (23 plots). This class is transitional and not clearly distinct from Class 2. It is characterized by lack of uniformity, some plots in 5 of the 8 sources having yellow green or deep green foliage. Poland, Germany, Italy. Latitude Range: 46° - 52°.

Class 4. Deep Dark Green Foliage (25 plots). Germany, Czechoslovakia Netherlands, Roumania, Latvia. Latitude Range: 45° - 55°. Some plots classed as blue green.

TABLE 1

WINTER FOLIAGE COLOR OF SCOTCH PINE, FEBRUARY, 1955

Seedlot number <u>1/</u>	Source	Latitude North	Number of plots
CLASS 1, PRONOUNCED BLUE-GREEN			
17	Scotland, Glengary	57° 04'	2
18	Belgium, Herselt	51° 03'	4
45	Czechoslovakia, High Tatra	49° 09'	6
(144)	Sweden, Knaftens By	64° 30'	1
(147)	Sweden, Berga	57° 10'	1
(162)	Germany, Offenbach (Hessen)	- -	1
(243)	Esthonia, Tartu	- -	3
(246)	Belgium	- -	1
(79)	Germany, East Prussia	54° 21'	1
(74)	Germany, Annaburg, Saxony	50° 25'	3
CLASS 2, BLUISH GREEN (RARELY WITH GOLD TIPS)			
<u>A. Northern Maritime Races</u>			
7	Norway, Svanøy	61° 29'	3 ^{2/}
11	Latvia, Vecomocas	57° 00'	5 ^{2/}
29	Finland, Bromarv	59° 56'	2
48	Sweden, Vitsand	60° 20'	3
<u>B. Continental Races</u>			
20	Poland, Pforten	51° 47'	7 ^{3/}
21	Germany, Hannover	52° 58'	4 ^{4/}
22	Poland, Rudczany	53° 40'	3
23	Germany, Elmstein	49° 22'	2
24	Germany, Zellhausen	50° 01'	2
25	Hungary, Lenti	46° 38'	2
33	Netherlands, Breda	51° 34'	3
34	Roumania, Tinocawa	47° 34'	3
36	Germany, Langenbrandt	48° 42'	2
(78)	Germany, Mecklenburg	53° 30'	3
(71)	Sweden, Central	57° 59'	2
CLASS 3, SLIGHTLY BLUE-GREEN			
31	Italy, Val di Fiemme	46° 18'	2 ^{2/}
35	Germany, Langensteinback	48° 55'	2
37	Poland, Suprasl Ia	51° 13'	4 ^{5/}
38	Poland, Suprasl Ib	51° 13'	2
39	Poland, Bolewoce IIa	52° 24'	3 ^{6/}
40	Poland, Bolewoce IIb	52° 24'	5 ^{4/}
54	Poland, Rychtal-A	51° 09'	4 ^{4/}
(156)	Germany, Eberswalde	- -	1

1/ Numbers without parentheses are IUFRO designations, those in parentheses are Fox numbers for seedlots that are not a part of the IUFRO test. 2/ One plot with gold tips. 3/ One plot slightly yellow. 4/ One plot deep green. 5/ One plot yellow green, one deep green. 6/ One plot yellow green.

TABLE 1 (Continued)

Seedlot number	Source	Latitude North	Number of plots
CLASS 4, DEEP DARK GREEN ^{7/}			
14	Roumania, Talmaciu (Talmacel)	45° 40'	<u>58/</u>
19	Netherlands, Diever	52° 51'	<u>58/</u>
43	Czechoslovakia, Tisnov	49° 21'	<u>28/</u>
44	Czechoslovakia, S. Bohemia	49° 00'	<u>38/</u>
32	Latvia, Griva (Guvass)	55° 50'	<u>79/</u>
(80)	Germany, Pilowmühle i Pommern	- -	1
(17)	Roumania, Carpathians, E. Mociaru	45° 52'	2
CLASS 5, DULL OR PALE YELLOW OR YELLOWISH GREEN			
10	Sweden, Böda	57° 15'	1
41	Poland, Susk IIIa	50° 55'	2
42	Czechoslovakia, Kurivody	50° 36'	<u>510/</u>
49	Sweden, Oxamo	57° 46'	<u>28/</u>
53	Poland, Mustjeki	54° 08'	<u>411/</u>
55	Poland, Luboml	51° 15'	4
(145)	Sweden, Norsjövallens By	64° 30'	1
(146)	Sweden, Halland	56° 30'	1
(161)	Germany, Breslau, Silesia	- -	1
(163)	Germany, Rudezanny Masuren, E. Prussia	- -	1
(72)	Finland, Central	62° -	1
(73)	Germany, Black Forest	- -	1
CLASS 6, YELLOW GREEN (OR BLUE GREEN) WITH GOLD TIPS ^{12/}			
6	Norway, Asnes (Solar)	60° 30'	4
8	Sweden, Voxna	61° 20'	<u>210/</u>
9	Sweden, Tonnersjöheden	56° 40'	<u>313/</u>
30	Norway, Modium	59° 56'	<u>310/</u>
46	Sweden, Vindeln	64° 12'	3
50	Sweden, Strömsund	63° 50'	3
CLASS 7, GOLDEN (OR BRIGHT YELLOW WITH GOLD TIPS) ^{14/}			
1	Finland, Inari	68° 55'	2
2	Finland, Rovaniemi	66° 30'	1
3	Finland, Säminki	61° 53'	<u>515/</u>
4	Norway, Tynset	62° 18'	2
5	Norway, Maiselv	69° 10'	2
47	Sweden, Brannberg	65° 47'	3
51	Sweden, Svenskadalen	64° 02'	2

7/ Good to excellent stem form. 8/ One plot blue green. 9/ Two plots pale blue green. 10/ One plot deep green. 11/ Two plots blue green, two plots yellow. 12/ Stout, short needles, fair to good form. 13/ All plots blue green with gold tips. 14/ Short needles, good form. Stunted growth. 15/ One plot blue green, other four plots yellow with gold tips. Blue green plot may be an error.

Class 5. Dull or Pale Yellow or Yellow Green (24 plots). This is a transitional class like Class 3. Some plots otherwise yellow sources were classed as deep green or blue green. Sweden Germany, Finland, Czechoslovakia, Poland. Latitude Range: 50°- 62°.

Class 6. Yellow Green (Rarely Blue Green) with Gold Tips (18 plots) This class is apparently near Class 2 with the common characteristic of gold tips. In general it includes the more continental areas of northern countries at medium high latitudes. Norway and Sweden. Latitude Range: 56° - 64°.

Class 7. Golden (with or without Gold Tips) (17 plots). These are the extreme far northern sources, near the arctic limit of tree growth. Norway, Sweden, Finland. Latitude Range: 62° - 69°.

Summary

Foliage of Scotch pine grown from seeds from the far north turned a bright yellow or gold with the approach of winter. This is characteristic of sources away from the seacoast and at high elevations north of 60° Lat. These trees exhibit a purple to green color in the seedling stage.

Continental sources in Scandinavia and Northern Germany and Eastern Europe turned a pale yellow in winter.

Coastal or maritime sources about the Baltic Sea as well as the Atlantic Coast and mountainous regions inland commonly retained their blue-green color through the winter. These were purple in the seedling stage.

Southern European sources and some coastal origins retained a deep green color.

There are many local exceptions and variations that can be explained only by a detailed study of the climate and other site factors of the place where the seed was collected.