Testing New Mexico Conifer Seed Sources for Christmas Tree Production[1]

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New Mexico white fir (**Abies concolor** [Gord. & Glend.] Lindl.), Douglas fir (**Pseudotsuga menziesii** [Mirb] Franco), southwestern white pine (**Pinus strobiformis** Engelm.) and blue spruce (**Picea pungens** Engelm.) have performed very well in Michigan (9, 5, 11, 3) and Pennsylvania (1) provenance studies. Excellent growth rates, good form, and deep blue foliage (with the exception of southern New Mexico white fir) have been reported and have created much interest in southwestern seed sources.

In the fall of 1975, the staff of New Mexico State University's Mora Research Center began collecting seed to conduct the first Christmas tree provenance studies within the natural range of the above species in the Southwest. The objective is to identify sources of fast-growing, frost-hardy trees with good form, color, and insect resistance.

New Mexico presently relies entirely on forest-grown and imported Christmas trees but the picture is changing. Improved seed will be used to establish test plantations in the northern mountains and central highlands. Identification and production of superior seed should also assist out-of-state growers as it becomes available through reputable dealers.

Growth, color, and form of southern New Mexico and Arizona sources have been very similar in eastern provenance studies so that division of the two populations into races is arbitrary and largely unsubstantiated.[5] Both produce seedlings capable of rapid growth and with generally deep blue-green foliage. Rapid growth becomes obvious when Douglas-fir and white fir seedlings from these origins are planted alongside seedlings from more northern, Colorado and Utah origins. Years ago, Douglas-fir and white fir required 18-20 years to produce Christmas trees in the East. More recently, the availability of seed from Arizona and New Mexico has reduced the rotation time by 50 percent where frost damage is not a serious problem. Tests comparing **Pinus flexilis** and closely related **P. strobiformis** have similarly shown the latter to have a much better growth rate.[5]

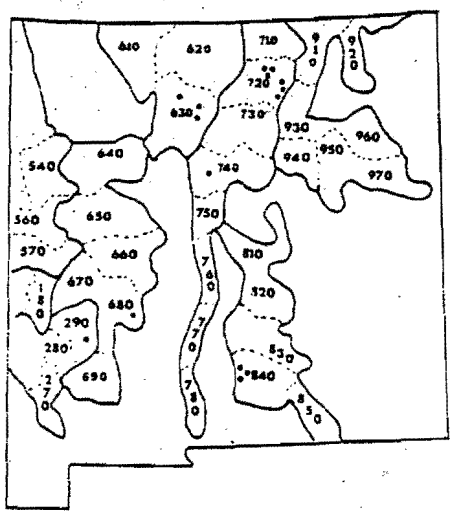

Fig. 1. Map showing seed sources of white fir included in statewide study. Numbered are provisional provenance tree-seed zones of Schubert and Pitcher (1973).

Bluish (glaucous) foliage, caused by deposition of a waxy covering, is common in southwestern conifers. For example **P. strobiformis** is one of the bluest of the white pines, and blue spruce and white fir are the bluest of their genera. Arizona and New Mexico seed sources of Douglas-fir are the bluest available to growers; and Rocky Mountain white fir is generally bluer than West Coast sources. Although some southern New Mexico white fir are much greener than southern Colorado sources, extremely glaucous specimens can be found in north central New Mexico. Purple cones are also common in the northern third of the state, whereas only green cones have been observed in the southern third.

The climate of the Southwest provides an explanation for glaucous foliage and the rapid growth rate of its conifers. The high evaporative demand of the atmosphere creates a need for restriction of plant water loss through development of a thick cuticle, common to desert plants. Southwest mountains receive intense solar radidation, and the blue light portion especially, breaks down auxin through photo-destruction. Reflection of blue light by foliage may, therefore, serve as an auxin-control mechanism.[5]

Temperature and growing season characteristics help explain the rapid growth of southern Rocky Mountain seed sources. Mean annual temperature decreases from south to north throughout New Mexico as distance from the equator increases. The general variation is 1.5 to 2.5 degrees Fahrenheit for each of the state's almost six degrees of latitude,[10] so that southern New Mexico is about 14 degrees warmer than the northern part. Moreover, the latitudinal gradient is slightly greater in winter than in summer.

In the northern part of the state the frost-free season averages only eighty days in the upper part of the Sangre de Cristo Mountains and 100 days in the Jemez Mountains. In the southern, Sacramento Mountains, a common origin for seed tested in the East, the growing season is 140-160 days. The frost-free season is from about May 10 through Oct. 10 in the Sacramento Mountains, June 20 to Sept. 10 in the northern mountains. The close of the growing season in the north is much more variable than its opening due to early winter storms.

Altitude also contributes to growth differences between southern and northern sources within the state. Generally altitude compensates for latitude so that the lower elevational limits of a tree species decreases as latitude increases. This relationship does not hold for Arizona and New Mexico where many conifer species and populations within species grow nearly 1000 feet lower in elevation than in states immediately to the north. Latitude and altitude differences, therefore, collectively magnify north-south differences within these states and the result is a much warmer climate and a longer growing season for southern populations.

These ciimatic relationships explain why southern New Mexico Douglas-fir breaks dormancy earlier and sets buds later than northern sources in Nebraska[6] and eastern[4] provenance tests. This can be a serious problem on some sites and growers may want to grow more hardy sources in part or exclusively as discussed by Steiner and Wright.[9] Where frost is not a serious problem, the faster growing sources can markedly reduce crop rotation time.

Seed of the above conifers have been collected throughout New Mexico for provenance testing. Because

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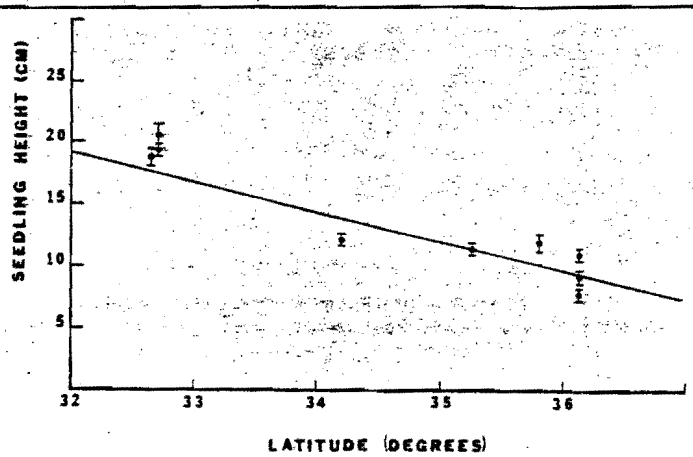

Fig. 2. Height growth of white fir seedlings in the greenhouse with different latitudinal but similar elevational seed origins (8000-8200 ft., 2438-2499 m). Y = 107.94 - 2.72 X, r2 = -0.96. Vertical bars represent ± one Standard Error of the mean.

white fir is the principal Christmas tree of the state, it received first attention and seed was collected from sources shown in Figure 1 in the fall of 1975. Figure 1 also identifies numbered provisional seed collection zones proposed by Schubert and Pitcher.[7] Seeds were sown in containers in the greenhouse in 1976 and planted in the spring of 1977.

Seedlings showed definite growth trends even before removal from the greenhouse. Figure 2 shows relative height growth of seedlings collected from sites with similar elevations (8000-8200 feet) but different latitudes covering more than 3 degrees and 200 statute miles. Growth and latitude were closely related in an inverse manner. As latitude increased, height growth decreased to the extent that seed sources in the Sacramento Mountains produced seedlings 2-3 times taller than those produced by northern New Mexico sources. Results, therefore, support white fir research performed in California where growth and latitude were strongly and clinally related.[2] Similar findings have been recorded for Douglas-fir.[6]

An immediate benefit to our program is that large fir seedlings can be produced in less time by using fast growing seed sources and fast growing containerized techniques. Larger seedlings compete more vigorously with weeds for moisture and nutrients, are less subject to frost,[9] and will move into the rapid, juvenile-growth phase earlier than smaller seedlings. Where irrigation water is required, large seedlings are also less affected by soil movement. These benefits are reflected in the better first-year survival of southern versus northern sources. Sources from near Hillsboro, (Gila N.F.) Mayhill and Mescalero (Lincoln N.F.) suffered only 2-3 percent mortality, whereas northern sources near Mora and Taos suffered as much as 12-15 percent mortality.

Very little frost damage was recorded and did not affect one source more than another. However, the winter was mild and this relationship may change in the future. Because seedling growth rate is generally strongly correlated with juvenile and adult growth, rankings in growth are not expected to change significantly within a Christmas tree rotation.

Southern New Mexico sources are expected to produce trees with the less desirable green foliage. However, foliage color is somewhat variable within stands, and intensive selection of parent stock will be imposed to identify the bluest sources. There is also the possibility of mating the faster growing southern sources with bluer northern New Mexico or southern Colorado sources.

Seedlings of the **P. flexilis - P. strobiformis** complex, Douglas-fir, and blue spruce were recently planted. We plan to conduct a simple selection program for all species mentioned, after we have determined on a broad scale the location of the better and faster growing sources. Silen and Wilson[8] reported substantial gain from a Douglas-fir improvement program involving only 100 randomly - selected, wind - pollinated parent trees. These were found within an area similar in size to the Mayhill, Cloudcroft, Weed triangle of the Sacramento Mountains. Individual parent tree selections for our program will be made within each of the superior seed source areas. These areas are separated by disjunctions of 10-50 miles which have probably created considerable genetic variability.[5]

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Winter Injury

Last year we reported serious winter injury to Spanish Scotch pine in some areas. This year it appears that the injury was even more serious. Apparently, the cold was more prolonged so that wherever the trees protruded through the snow, serious needle injury occurred.

Some injury occurred to the greener varieties of Douglas fir, but because of the deep snow, ground freezing was not too deep and probably minimized injury to younger stock. In our experience it seems Douglas fir tends to "toughen up" with age.

We're just pointing out that extreme winter or other infrequent environmental phenomena need to be experienced before we put all our "golden eggs" of research in one basket!