Seed source and region effects on growth rate and survival of blue spruce (Picea pungens) Christmas trees in New Jersey

SEED SOURCE AND REGION EFFECTS ON GROWTH RATE AND SURVIVAL OF BLUE SPRUCE (*Picea pungens*) CHRISTMAS TREES IN NEW JERSEY

MARCIA S. MEIXLER, MARK C. VODAK AND GREGORY A. MCLAUGHLIN

Rutgers Cooperative Extension
Cook College, Rutgers University
New Brunswick, New Jersey 08903

ABSTRACT. *Seedlings from five different seed sources of blue spruce Christmas trees were planted at five sites throughout New Jersey. Two sites in northern New Jersey and one in central New Jersey had significantly higher survival rates than the two in southern New Jersey. Additionally, the two sites in northern New Jersey had significantly faster growth rates than those in southern and central New Jersey. There were no significant differences in survival rates between seed sources. In terms of growth rates, however, seedlings from seeds obtained in Santa Fe National Forest, New Mexico grew significantly faster than seedlings from the other seed sources tested. This further growth rate is predicted to shorten the time needed to reach marketability size by one to five years.*

Key Words: blue spruce, seed source, Picea pungens, provenance

In terms of gross wholesale farm price, Christmas trees are a sixteen million dollar industry in New Jersey. According to the New Jersey Christmas Tree Growers Association, in 1989 alone approximately 550,000 Christmas trees were sold (Dupras, 1993). Along the entire Middle Atlantic region, the industry is much larger.

Blue spruce (*Picea pungens*), a native of the central and southern Rocky Mountains, ranks among the most popular Christmas trees grown in New Jersey due to its unique blue color, good needle retention and natural symmetrical shape (Fechner, 1990; Hanover, 1978). Unfortunately, blue spruce has a slow growth rate compared to other popular Christmas trees (Chapman and Wray, 1979). For example, Norway spruce and white pine take only six to eight years to reach salable height while blue spruce currently takes ten to fifteen years, rendering it less profitable for growers (Kidd *et al*, 1973).

The New Jersey Christmas Tree Growers Association asked Rutgers Cooperative Extension to test seedlings obtained from the southern Rocky Mountain region to find a specific blue spruce seed source which would yield trees with rapid growth and high survival rates, while still maintaining characteristics attractive to customers.

MATERIALS AND METHODS. A total of seven hundred and fifty seedlings - one hundred and fifty seedlings from each of five seed sources - were obtained from five National Forests: Kaibab National Forest in Arizona, San Juan and Rio Grande National Forests in Colorado, and Lincoln and Santa Fe National Forests in New Mexico. Within each National Forest, seed was collected from wild, "woods-run" trees. These seedlings were bought in 1986 from a nursery in Connecticut as 2-0 bare root stock. They were then grown one additional season at the Rutgers Horticulture Farm I in New Brunswick before distribution to four additional sites throughout the state. These five sites were chosen to represent the five different physiographic sections of New Jersey (Figure 1). The town of Newton in Sussex County represents the Ridge and Valley section, Belvidere in Warren County represents the Highlands section, New Brunswick in Middlesex County represents the Piedmont section, Medford in Burlington County represents the Inner Coastal Plain section, and Marmora in Cape May County represents the Outer Coastal Plain section. Each site received thirty seedlings from each of the five seed sources; and the seedlings were planted in a Latin square design. All sites except the New Brunswick site (which was owned by Rutgers University) were planted and maintained by cooperating Christmas tree growers.

Measurements of leader growth and mortality were recorded for three growing seasons following planting. After determining that the data were normally distributed with homogeneous variances, an analysis of variance (ANOVA) was performed. ANOVA ($P=0.05$) was used to determine whether seed source or region differences caused significant variations in growth or survival rates. Duncan's multiple range test ($P=0.05$) was used to determine which sources and regions were significantly different (SAS, 1982).

RESULTS. The results of this study are shown in Table I. Mean survival of the trees from all seed sources at the five New Jersey sites after three years was 64% and the mean height was 52.47 centimeters. Due to excessively low survival rates in Cape May County,

growth rates for this county were not used in the computation of the total mean height for each seed source in Table I.

The data were analyzed to test for four potential effects: an effect of region on growth rate, an effect of region on survival rates, an effect of seed source on growth rate and, an effect of seed source on survival rates. In terms of regions, the northern New Jersey sites in Warren and Sussex Counties yielded significantly faster growing trees than the three counties in central and southern New Jersey. The highest mean survival rates were seen in seedlings grown in Warren, Sussex, and Middlesex Counties. Seedlings grown in Burlington County had significantly lower survival rates, and the survival of those grown in Cape May County was lower still. In terms of seed source, Santa Fe National Forest had a significantly faster growth rate than all the other seed sources. However, differences in survival rates among seed sources were non-existent.

Overall, blue spruce seedlings grown in the southern physiographic sections of New Jersey had a more difficult time reaching maturity and a slower growth rate. The most successful combination yielding the highest levels of growth and survival rates were seedlings from Santa Fe National Forest grown in Warren or Sussex Counties in northwest New Jersey.

DISCUSSION AND RECOMMENDATIONS. The theory that blue spruce seedlings will grow best under conditions most closely approximating its native conditions was tested and proven indirectly using the various physiographic sections of New Jersey. The large differences in survival and growth rates of the seedlings at different sites throughout New Jersey suggest that ecological differences across the state have a large effect on blue spruce Christmas trees. The soils of southern New Jersey, where the seedlings had the lowest survival and growth rates, are made up of a large amount of quartz sand which is low in fertility and retains little of the moisture needed for growth (Collins and Anderson, 1994). In addition, the acidity level of this area (pH of 5.0 or less) is higher than that of blue spruce's native soils (pH of 6.8 to 7.2 and moist [Fechner, 1990]). The sandy southern New Jersey soils characteristically have less organic content and lower nutrient levels due to higher leaching and erosion rates. Alternatively, the soils in northern New Jersey generally have pH levels of 5.5 or greater and a higher moisture level (Drake and Motto, 1982; Motto, 1994), much like that of blue spruce's native soils. The higher survival and growth rates of northern New Jersey seem to support this theory.

In terms of survival, seed source has no significant effect. The growth rate of the Santa Fe seed source, however, is significantly faster than that of all the other seed sources in the study.

Using 12.5 years as the average growth time for blue spruce seedlings to reach a salable height of six feet, we see that the average blue spruce seedling grows 14.4 centimeters per year. The Santa Fe seedlings in this study grew at an average rate of 18.5 centimeters per year. Through linear extrapolation these seedlings are likely to reach salable height in a total growth time of 9.7 years, shortening production time by one to five years while still maintaining high survival rates and attractive characteristics.

It is important to note, however, that the Santa Fe National Forest, from which the Santa Fe seed source was taken, is quite large. Thus, the potential exists for significant differences in desirable growth characteristics of seedlots originating from different areas within the forest due to genetic variation. Future studies are recommended to test seedlots from identifiable areas within the forest to distinguish and isolate those that consistently produce more desirable seedlots. Ultimately, once identified, such seedlots could be economically produced through cloning techniques in sufficient volumes for commercial growers.

ACKNOWLEDGMENTS

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TABLE I. Mean height (cm) and percent survival of blue spruce from five seed sources in five regions of New Jersey after three growing seasons.

Seed Source Means	State	Mean height and percent survival by region					Overall
		Warren	Sussex	Middlesex	Burlington	Cape May	
Kaibab N.F.	AZ						
Mean height (cm)		52.8	55.7	46.6	43.8	0	51.7 B
Percent survival		90.0	83.3	80.0	63.3	0	63.3 A
San Juan N.F.	CO						
Mean height (cm)		60.1	52.5	45.3	48.0	0	51.9 B
Percent survival		86.7	76.7	83.3	46.7	0	58.7 A
Rio Grande N.F.	CO						
Mean height (cm)		57.8	56.9	49.0	43.0	50.0	52.2 B
Percent survival		73.3	76.7	73.3	56.7	3.3	56.0 A
Lincoln N.F.	NM						
Mean height (cm)		56.4	55.8	45.7	45.2	24.0	50.8 B
Percent survival		96.7	93.3	96.7	76.7	3.3	72.7 A
Santa Fe N.F.	NM						
Mean height (cm)		61.6	60.9	49.2	47.1	45.0	55.6 A
Percent survival		100.0	86.7	86.7	66.7	10.0	70.0 A
Region mean height		58.9 A	56.4 A	47.5 B	45.3 B	41.8 B	
Region mean survival		83.3 A	89.3 A	84.0 A	61.3 B	3.3 C	

Numbers marked with the same letter are statistically indistinguishable by Duncan's multiple range test (P=0.05).

Due to excessively low growth rates, observations from Cape May County were not included in the total mean height calculations.

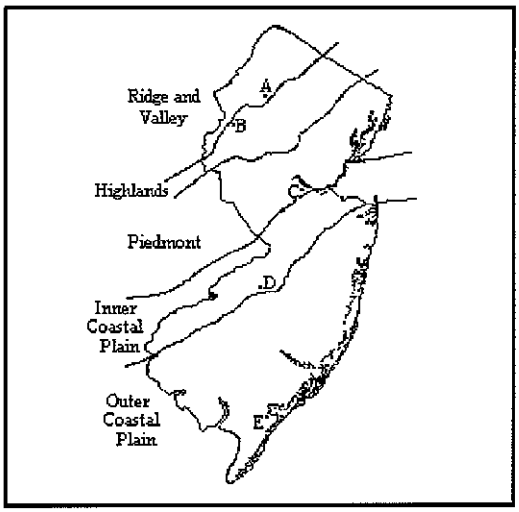
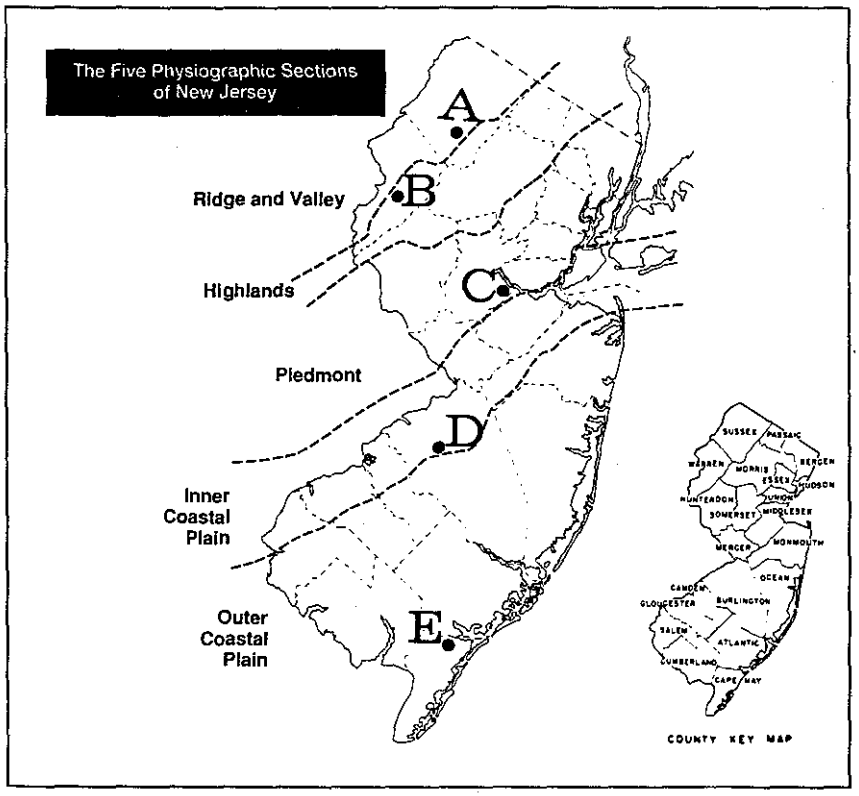


FIGURE 1. The five test sites in each of the physiographic sections of New Jersey (SOURCE: Beryl Robichaud Collins and Karl H. Anderson, Plant Communities of New Jersey , copyright 1994 by Beryl Robichaud Collins and Karl H. Anderson. Reprinted by permission of Rutgers University Press.)

A Newton in Sussex County
B Belvidere in Warren County
C New Brunswick in Middlesex County
D Medford in Burlington County
E Marmora in Cape May County



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