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Performance of Himalayan Blue Pine in the Northeastern United States

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Based on its performance in an area with a large weevil population, Himalayan blue pine (Pinus wallichiana *A.B. Jacks) is not weevil resistant and any growth potential in this area is disguised by repeated weevil attacks. Blue pine may have desirable traits that should be studied outside the areas of greatest weevil concentration.* Tree Planters' Notes 43(3):76-80: 1992.

Because plantations of eastern white pine (*Pinus strobus* L.), the only native soft pine in the northeastern United States, are frequently damaged by numerous insects, diseases, and atmospheric pollutants (Garrett 1985), attempts have been made to develop resistance in this species since the 1930's. Another approach would be to find a different species with similar characteristics that could be used as a substitute for, or in hybrid combination with, eastern white pine.

Exotic 5-needled pines have been planted in this region and some have exhibited varying levels of resistance to blister rust (*Cronartium ribicola* J.C. Fisch. ex. Rabenh) and/or white pine weevil (*Pissodes strobi* Peck). However, only Himalayan blue pine has been planted in numbers large enough to provide meaningful information.

Himalayan blue pine (also known as *P. excelsa* Wall., *P. griffithii* McClelland, and *P. chylla* Lodd.), is a major component of middle- and high- elevation Himalayan forests from eastern Afghanistan to Yunnan Province in China. This 5-needle pine in the genus *Pinus*, subgenus *Strobus*, is closely related to the North American *P. strobus* in the East and *P. monticola* in the West, and closely resembles both of these species in many morphological characteristics. On good sites in its native range, this species is one of the fastest growing conifer species in the world and reaches heights of 50 m (165 feet) (Ahsan 1972).

With the extensive range of blue pine and its discontinuous distribution at elevations of 1,500 to 3,400 m (5,000 to 11,000 feet), there is a strong possibility of geographic variation. Dogra (1972) reported several altitudinal races from different regions in the Himalayas, and Siddiqui (1972) identified mesic and xeric types in northern Pakistan.

Wright and Gabriel (1959) planted several specimens of blue pine near Philadelphia (lat. 40° N, long. 75° W) and reported excellent growth and form. Their observations that this species is rarely attacked by the white pine weevil supported earlier comments by McAloney (1943). Lemmien and Wright (1963) reported that they found 3 times as much weeviling in a 32-year-old planting of blue pine as in eastern white pine of the same age in southern Michigan (lat. 42° 20' N, long. 85° 20' W). Reports by Clinton and McCormick (1919), Spaulding (1925), Childs and Bedwell (1948), and several others in recent years indicate that blue pine is resistant to blister rust (Garrett 1985).

Kriebel and Dogra (1986) reported on a planting of single-tree seedlots from Afghanistan, Pakistan, India, and Nepal that were established to study the cold-hardiness of blue pine in Ohio (lat. 40° 15' N, long. 82° W). Most of the sources from the monsoon side of the western Himalayas were faster growing but less cold-tolerant than those from the drier eastern slopes of the Himalayas. They concluded that it should be possible to extend successful plantings of this species northward in the eastern United States by careful selection of suitable provenances. They also concluded that cold hardiness is the limiting factor, but that there is wide genetic variability in this trait that can be exploited.

Many of the same seedlots tested in Ohio were planted in 1988 in Tennessee (Schlarbaum and Cox 1991), where less than 50% survived at each of three locations. Low survival was attributed to drought conditions. Tennessee may be a good location for studying growth rates but probably is not suitable for studying cold-hardiness or weevil resistance.

Several of the studies in Ohio and elsewhere were looking not only at the performance of this species for timber qualities, but also as another species that could be used as a Christmas tree and in the landscape trade. The tree received its name

because the foliage appears bluer than other pines. The needles also tend to be slightly longer than eastern white pine and droop at the ends, giving the tree an attractive appearance.

Because blue pine crosses so readily with eastern white pine, a number of plantings of hybrids between these species has been established in the United States and Canada. Again, results have been contradictory. Wright (1959), Kriebel (1963, 1983), and Radu (1976) reported excellent growth of *P. strobus* X *P. wallichiana* and the reciprocal cross in the nursery. Measurements of Wright's trees 20 years after outplanting indicate that the *P. strobus x P. wallachiana* hybrids were about the same size as *P. strobus* and that the *P. wallichiana* X *P. strobus* were shorter (Garrett 1979). Heimburger (1964) reported a higher than expected proportion of rust-resistant seedlings of the *P. wallichiana* X *P. strobus* hybrid. Zsuffa (1979) reported that *P. strobus* X *P. wallichiana* outgrew *P. strobus* by 60% at age 6 in southeastern Ontario. Garrett (1970) found that grafted *P. strobus* X *P. wallachiana* was as severely and uniformly weeviled as "susceptible" *P. strobus* in the same area of southern Maine.

Materials and Methods

Because many of the earlier papers were based on observations of small or unreplicated plantings in areas where weeviling is not serious and the results were contradictory, we established progeny/ provenance tests in the Northeast to evaluate growth and weevil resistance. Fifty-six half-sib seedlots from six provenances of blue pine were obtained from the Pakistan Forest Institute in Peshawar. A completely randomized, single-tree plot design with 10 replicates per seedlot was planted during the spring of 1976 on the Massabesic Experimental Forest in York County, Maine (lat. 43° 30' N, long. 70° 45' W). Four row plots, each containing 10 eastern white pine seedlings from a local source, were randomly located throughout the planting for comparison purposes (figure 1).

Trees were planted on an area that had supported a vigorously growing stand of white pine. The area was logged, stumps removed, and the ground rotary-tilled before planting. Rows were 2.5 m (8 feet) apart and trees within rows were 1.8 m (6 feet) apart. The space between trees was

Figure 1—*Blue pine provenance/progeny trial in southern Maine. These seedlings planted in May 1976 were photographed in September 1984. Note the shorter, badly weeviled blue pines on the left and the taller controls of eastern white pine on the right.*

mowed periodically to eliminate weeds and volunteer white pine reproduction. Damage by the white pine weevil was evident on trees of all ages in surrounding stands and throughout the area, so uniform exposure was anticipated.

Seedlings were grown in the greenhouse for 7 months and then planted in the field so the total ages from seed are effectively 5 and 10 years. Survival and heights were recorded at 4 and 9 years after planting and weeviling was recorded at 9 years. Only successful weeviling (dead main-stem leader and larval cavities) as opposed to unsuccessful weeviling (feeding punctures, resin flow, possible reduced growth) during the previous spring was counted. It was apparent that successful weeviling had occurred in previous years, but it would have been difficult to differentiate weeviling from main stem offsets due to other causes.

ANOVA was used only on the heights at age 9. Weeviling data only reflected the current years' injury.

Table 1—*Height, survival, and weeviling of blue and white pines in Maine*

	Height (ft)		Survival (%)		Weeviling (%)
	Fall 1979	Fall 1984	Fall 1979	Fall 1984	Fall 1984
Provenance	4 yrs	9 yrs	4 yrs	9 yrs	9 yrs
Bagh-e-lela	1.56	3.69	99	92	47
Bamburet	1.39	3.30	100	88	49
Kalabagh	1.83	3.19	98	79	86
Kalkot	1.65	3.62	100	84	67
Kern	1.51	3.33	98	79	67
Utror	1.58	3.35	97	81	67
White pine	1.89	7.77	100	100	51

Results

Survival and cold injury. Survival of all planted blue pine was 99% at the end of the fourth growing season and remained an acceptable 85% after 9 years (table 1). Survival of blue pine provenances in 1984 ranged from 92 (Bagh-e-lela) to 79% (Kern and Kalabagh). There was no visible injury to either buds or shoots that could be attributed to cold temperatures in spring or fall. Older needles of blue pine tend to turn yellow earlier than eastern white pine in the fall before shedding, and most needles are a lighter color throughout the winter season.

Because past weeviling attacks and height are related, these traits are discussed together.

Height growth of the blue pine through age 4 was similar to that of the white pine but by 1984 white pine was more than twice as tall as blue pine (table 1). There were statistically significant differences for height growth, probably because of the large differences in means between the provenances of blue pine compared to those of the white pine.

Weeviling is a serious problem in this location and may explain some of the difference in height growth between the two species. We recorded only dead current-year leaders, and weevil damage before age 9 undoubtedly was responsible for some reduction in growth. Weeviling between provenances of blue pine ranged from 47 to 86% and weeviling of white pine was 51% at the same age (table 1).

Blue pine has large-diameter terminal leaders, which may account for the species being so susceptible to weevil attacks at a younger age, compared to eastern white pine. It is well known that the larger diameter leaders of open-grown eastern white pine are more susceptible. Because of the short total height of most individuals in this planting, it was difficult to determine exactly when the trees were first attacked or how often this damage occurred. On the basis of feeding scars and offsets on the main stems, it appears that the blue pines were weeviled frequently prior to 1984, where as white pine was just beginning to be attacked at that time. This would be a contributing factor to the height differences between species observed in 1984.

Although this finding wasn't addressed statistically it is interesting to note that the tallest provenance (Bagh-e-lela) also had the highest survival and the lowest weevil attack in 1984. However, if one were looking for favorable combinations of traits, it would be advisable to consider seed lots within provenances. Seedlings of lot 144 (Bagh-e-lela) had slightly below-average height but 100% survival and only 13% weeviling. Lot 173 (Bamburet) had above-average height, 100% survival and only 22% weeviling. Individuals within progenies also expressed variable growth and weeviling that might be useful. Sixteen blue pine trees in this planting were at least 1.74 m (5.7 feet) tall and 3 were 2.14 m (7.0 feet) or more. Of these, 4 were not weeviled in 1984, though they may have been attacked in previous years. Six of the white pines were more than 3.1 m (10.0 feet) tall and 2 of these were unweeviled.

Discussion

The distribution pattern of blue pine suggests that natural variation at the seed source level could have developed for a number of important traits such as growth rate, cold tolerance, and needle color and retention. Studies in Pakistan confirm that provenances do perform differently on different sites (Siddiqui 1988). Seed lots or individual tree selections within provenances throughout the native range of blue pine would be expected to yield trees with acceptable growth rates on some sites in the eastern United States and Canada. Blue pine's compact form and desirable foliage color during the juvenile growth period, desirable traits for landscape purposes or for Christmas tree production, was another reason for looking at this species in the Northeast.

On the basis of our results with this limited number of provenances and progenies, we conclude that:

1. Survival of blue pine when planted this far north (lat. 43° 30' N) is at an acceptable level.
2. Himalayan blue pine is slower growing than native white pine in southern Maine for several possible reasons.
3. Blue pine is at least as susceptible to white pine weevil damage as eastern white pine in the Northeast where heavy weeviling is a frequent occurrence.
4. Early yellowing and loss of older needles in the fall season would be a drawback for Christmas tree growers at this latitude.

Although our planting contained more provenances and progenies than any other trial outside of Pakistan or India at the time, it was still limited to a relatively few sources from about one-quarter of the natural range of this species. Based on our observations 9 years after planting in the field, Himalayan blue pine would not seem to be a good candidate to replace eastern white pine in the northeastern United States or southeastern Canada.

If additional sources of seed could be obtained from other parts of the range (India, Nepal, Bhutan, and China), additional planting should be established in this same area and in areas more nearly approximating the latitude of the collections (lat. 34° to 37° N), probably between 39° and 41° N. Plantings in those latitudes should retain good needle color later in the season, a trait that is essential in Christmas trees. Such plantings also would be outside the region of heaviest weevil populations, though spraying to control weevil damage would be economically justified for this product.

Additional work is needed with hybrids containing blue pine and other potentially valuable 5-needled pines. The germplasm of blue pine used in previous crossing experiments with other white pine species has not been from "select" parent trees, and even the provenance often was unknown. Most work was done in arboreta where individuals of flowering age were available and used regardless of their phenotype or genotype. Therefore, performance of hybrids has been based on the qualities of a few biotypes at most and should not be used as an indication of the genetic potential of this species. The entire white pine species/hybrid complex is essentially unexplored and could contain solutions to many of the serious problems related to pests and atmospheric pollution in the Northeast.

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