15-Year Performance of European Black Pine in Provenance Tests in North Central United States[1])

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(Received February / March 1976)

Introduction

European black pine *(Pinus nigra* Arnold) is a widespread timber tree of the mountains of southern Europe and Asia Minor, with outliers in many of the Mediterranean islands and in northern Africa (Critchfield and Little, 1966). Geographic varieties of the species are known by other common names such as Austrian pine, Corsican pine, and Calabrian pine.

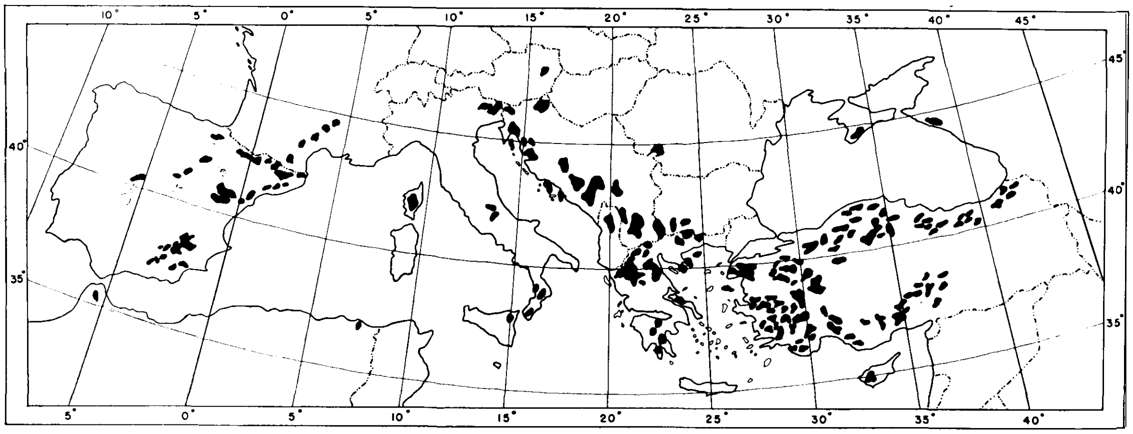

Figure 1. — Natural range of *Pinus nigra* Arnold. (from Lee, 1968).

This species, mainly the Austrian variety, was introduced into the United States in 1759, and has been planted as an ornamental or windbreak tree in most of the northern and central states ever since. Forest plantations of it are few, however. It is better suited to calcareous soils than most pines and is very tolerant of salt spray. This salt tolerance makes it an excellent screen tree along heavily travelled roads which are salted during the winter. It also responds well to shearing and for that reason makes an excellent evergreen hedge plant and a good Christmas tree.

In the United States, European black pine has been subject to some damaging leaf and twig diseases. For the most part the damage has been confined to trees more than 50 years old. In recent years, however, there have been some serious outbreaks, particularly in the plains states, on younger plantations. These outbreaks have made the future planting of this species in the midwest and plains states doubtful unless resistant trees could be found.

Research on the genetic improvement of European black pine has recently been summarized by Vidakovic (1974). There has been a great deal of work on hybridizing it with other species, a small amount of work on plus tree selection and progeny testing, and a few provenance tests. Of these provenance tests, four have been replicated and deserve further mention. The oldest and largest (20-year data, six plantations, 39 natural-stand and 9 plantation progenies) was conducted in New Zealand (Wilcox and Miller, 1974). The second, with four plantations and 18 stand-progenies, was established in West Germany in 1956—57 (Röhrig, 1966); unfortunately the plantations became so badly damaged by *Scleroderris* disease as to be abandoned after the 10 th year (Röhrig, personal communication). The third was the NC-99 experiment described in further detail in the present paper; it includes 24 natural-stand and 3 plantation progenies, five plantations and was started in 1958. The fourth is the 31-origin, 3-year study conducted in France by Arbez and Millier.

Unfortunately, no two of these four experiment contain exactly the same seedlots, so only general comparisons are possible. Differences in growth rate have been more modest than found in most other species with very large natural ranges. Trees from Corsica proved fastest growing in New Zealand but were susceptible to winter damage and therefore slow growing in West Germany, France, and the United States. All authors reported considerable variation in non-growth characters (needle length, needle color and curvature, bud color, etc.). Relatively little success has attended efforts to correlate the genetic variation pattern in such traits with the variation pattern described in taxonomic treatises.

The NC-99 provenance test described in this paper was undertaken to provide practical information on the best seed sources for planting in north central United States and theoretical information to use in the further improvement of the species. This paper, based upon 15-year data from all plantations, is the first publication devoted to the entire experiment. Previous publications devoted to parts of the experiment are thase published by Wright and Bull (1962), Lee (1968, 1970, 1971) and Peterson and Read (1971).

[1]) Approved for publication as Journal Article No. 7568 of the Michigan Agricultural Experiment Station. The work was supported in part by regional research funds supplied by the U.S. Dept. of Agriculture as part of NC-99 project entitled "Improvement of Forest Trees through Selection and Breeding". The study reported here was done in partial fulfillment of the M. S. degree of the senior author at Michigan State University.

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Materials and Methods

Seed was obtained in 1958 from 10 or more average trees in each of 24 native stands and three plantations *(Fig. 2)*. The seeds were kept separate by stand but not by individual parent. They were sown in a nursery at East Lansing, Michigan in the spring of 1959 and grown for 2 years. In the spring of 1961 seedlings were shipped to cooperators in several north central states and 14 permanent plantations were established. Due to problems in shipping, initial mortality was high; of the 14 plantations, only 5 had sufficient survival to provide useful data.

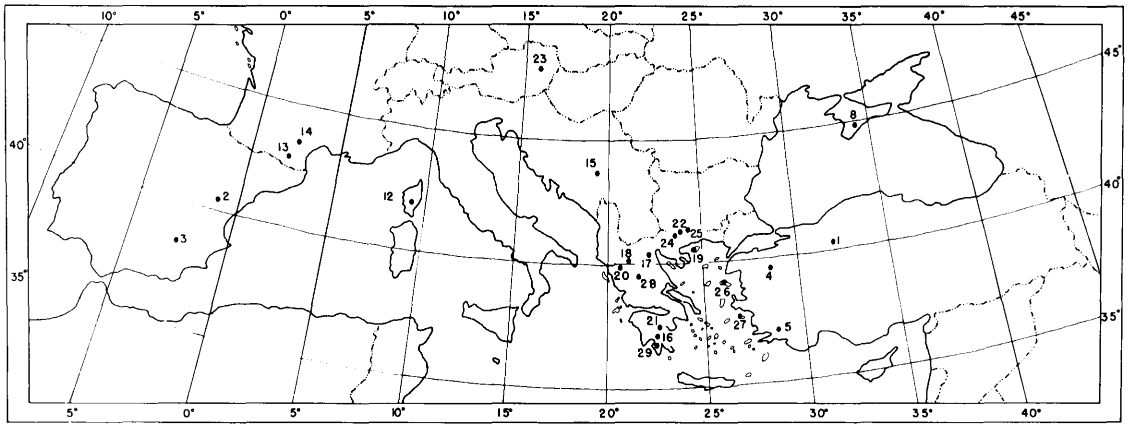

Figure 2. — Distribution of native stands of *Pinus nigra* represented in the present provenance study. Seedlots ITA-7, FRA-10 and COR-11 were obtained from plantations in France and Belgium and are not shown on this map. (Add 400 to each number to obtain equivalent number in previous NC-99 publications.)

A randomized complete block design with 4-tree plots and with five to ten replications was used in each plantation. Spacing between trees varied from 7 × 7 ft (2.1 × 2.1 m) to 10 × 10 ft (3 × 3 m). The trees were planted in furrows and kept weed-free for 1 year by means of chemicals. First-year mortality was partially replaced. Details of the five plantations providing useful data follow:

W. K. Kellogg Forest near Augusta, Kalamazoo Co., Mich. Site rolling with slopes of 0 to 25%, with Oshtemo loamy sand; mortality 17%; average height (age 15) 15.6 ft (4.8 m).

Fred Russ Forest near Dowagiac, Cass Co., Mich. Site level with clay soil; mortality 47%; average height (age 15) 14.5 ft (4.4 m).

Dunbar Forest Experiment Station near Sault Ste. Marie, Chippewa Co., Mich. Site level, sandy, poorly drained in spring; mortality 41%; average height (age 9) 3.2 ft (1.0 m); winter injury repeated and severe on all except a few seedlots.

Apple Creek State Hospital near Wooster, Wayne Co., Ohio. Site level with a clay loam soil; mortality 34%; average height (age 8) 5.3 ft (1.6 m).

Horning State Farm near Plattsmouth, Cass Co., Nebraska. Site a 6% east slope with a silt loam of loess origin; mortality 18%; average height (age 15) 17.3 ft (5.2 m).

In each plantation height, mortality and damage from cold or pests was measured several times, the last times in 1965—67 (Apple Creek and Dunbar) or 1973 (other plantations). The presence of cones or pollen was also recorded on each visit to a plantation. In the Kellogg Forest several additional leaf and wood characteristics were measured (see papers by Lee). Each set of measurement data from a single plantation was subjected to analysis of variance. In these analyses the degrees of freedom varied from 20 to 26 for seedlot, from 4 to 9 for block and from 78 to 225 for error.

Results

Mortality. Average mortality varied from 17 to 47% among the five plantations which have been measured. Most of the deaths occurred the first two years after planting. Trees from Corsica suffered the most mortality, averaging 49% dead vs 25% dead for all other seedlots. They had suffered severe winter injury while in the nursery and undoubtedly that winter injury contributed to their early death after field planting.

Winter injury. The Dunbar Forest plantation in northern Michigan is situated in a region with average January temperatures of 14° F (—10° C) and 40-year minimums of —37° F (—38° C), much colder than enountered anywhere within the natural range of European black pine. Only the two most northern seedlots, 23-AUS and 15-YUG, escaped winter injury often enough to develop as trees. Nearly all the other trees suffered such repeated top dieback that they grew ony as tall as the protective cover of the snow permitted.

The other four plantations are situated in regions with average January temperatures of 23 to 28° F (—5 to —2° C). In them, winter injury took the form of brown needle tips over part or most of the crown. Only rarely was there cambial injury or twig dieback. The amount of damage varied considerably from year to year and place and is difficult to quantify exactly. However, the seedlots can be placed in one of four groups according to the percentage of trees affected after severe winters. Such a grouping follows:

Proportion of trees affected	*Seedlots*
50 to 75 %	11-COR, 12-COR, 13-FRA
10 to 40%	7-ITA, 10-FRA, 14-FRA
5 to 20%	2-SPA, 3-SPA
0 to 10%	Austrian, Yugoslav, Greek, Turkish, Crimean

Thus, in general, trees from the eastern half of the natural range were the most winter hardy.

Growth rate. Relative heights of all seedlots in four plantations are given in *Table 1*. Data from Dunbar Forest were omitted because only seedlots 23-AUS and 15-YUG projected enough above the snow line to be regarded as trees.

The Corsican and south French seedlots which suffered the most severe winter injury also grew the most slowly in all plantations. The three most northerly seedlots (23-AUS, I-CRI, and 15-YUG) grew at above average rates at all places. Among the others it was difficult to make any generalizations as to geographic trends. For example, seedlots 22-GRE and 24-GRE from the same part of Macedonia were almost as different as seedlots from several hundred miles apart. However, there was a noticeable tendency for seedlots which grew well at one place to excel at other places.

Table 1. — Relative height of *Pinus nigra* seedlots grown at four places in north central United States.

Seedlot No.[1]) and origin	Relative height when planted at			
	Apple Creek, Ohio Age 8	Horning Farm, Neb. Age 15	Kellogg Forest, Mich. Age 15	Russ Forest, Mich. Age 15
	% of plantation mean			
2-SPA	113	98	103	101
3-SPA	97	87	89	97
7-ITA[2])	131	109	114	121
10-FRA[2])	122	—	114	95
13-FRA	—	—	84	70
14-FRA	89	—	89	85
11-COR[2])	55	—	89	85
12-COR	—	84	86	70
23-AUS	105	105	106	103
15-YUG	111	111	106	102
16-GRE	—	—	68	—
17-GRE	101	110	108	98
18-GRE	107	105	105	115
19-GRE	109	106	111	113
20-GRE	95	106	111	113
21-GRE	76	85	84	87
22-GRE	95		108	113
24-GRE	95	80	86	87
25-GRE	116	—	110	102
26-GRE	95	91	97	104
27-GRE	—	106	105	99
28-GRE	101	104	105	97
29-GRE	—	—	81	87
8-CRI	113	107	114	109
1-TUR	91	96	95	86
4-TUR	95	97	111	103
5-TUR	95	95	103	94
Actual mean, ft	5.3	17.3	15.6	14.5
Actual mean, m	1.6	5.3	4.8	4.4
F ratio for seedlot	7.2***	7.9***	5.1***	2.2**
Least significant difference between seedlots, 5% level	18%	11%	17%	19%

[1]) Seedlots 1, 2, 3, etc. were referred to as seedlots 401, 402, 403, etc., respectively in previous NC-99 publications. Names of regions are: AUStria, CORsica, CRImean SSR, FRAnce, GREece, ITAly, SPAin, TURkey, YUGoslavia.

[2]) Parental stand was a plantation of the presumed origin shown
, * = statistically significant at 1 or 0.1% levels, respectively.

Trunk diameter at a 1-ft height was measured at the Russ Forest only. At age 15 the plantation averaged 14.5 ft (4.4 m) tall and 5.3 inches (13.5 cm) in diameter; The height but not the diameter differences were statistically significant. In general, the tallest seedlots had the largest diameters (6 inches = 16.2 cm).

Multiple sets of height measurements were made in the Nebraska and two southern Michigan plantations. With increasing age, percentage differences in growth rate became less. At age 5 the tallest seedlots were 2 to 2.5 times as tall as the shortest ones; at age 15 they were only 1.5 times as tall as the shortest ones. There were, nevertheless strong age-age correlations and most seedlots which were above average at age 5 remained above average. This situation may not continue for serious disease epidemics developed in two of the plantations in the early 1970's. If the disease damage continues, height growth is more likely to depend on inherent resistance than upon inherent growth rate.

Disease damage. Serious disease epidemics occurred in two test plantations. Damage was so great as to indicate that the genetic data on resistance which were gathered subsequently are more important than those on growth rate.

The first epidemic was a needle blight caused by *Dothistroma pini* which began in 1967 in the Plattsmouth, Nebraska plantation. This fungus has caused extensive damage to shelterbelt plantings in several Great Plains states and has been observed on *Pinus nigra* in other countries (Peterson, 1967). The fungus infects current and previous year's foliage, resulting in browning and death of the needles. Continued infection causes mortality. In the Plattsmouth plantation there was so much damage by 1969 that the plantation was sprayed with a fungicide in order to preserve it for demonstration purposes and the measurement of other traits. Otherwise it was felt that all but the most resistant trees would die. Thus the plantation was healthy in 1969—1970 but became badly reinfected by 1972. Generally the same trees which were badly infected the first time became badly infected the second time.

The other epidemic occurred in 1972—1973 at the Kellogg Forest in southern Michigan and was caused by the fungus *Cenangium ferruginosum* (identification courtesy of Dr. J. Hart, forest pathologist of Michigan State University). This is a twig disease which has not been commonly reported in the United States but has caused extensive damage in several other countries (Lengyel, 1963; Lorentz, 1967; Lukonski, 19668). Some authors have felt that it was a primary saprophyte while others felt it was secondary, causing most damage to trees which had been weakened by adverse weather conditions. Most reports agree that serious epidemics are periodic, and that damage may be severe in one year but minor for several subsequent years.

The Kellogg Forest epidemic of *Cenangium* was serious in 1972—1973 but subsided the next year even though no control was practiced. Over 44% of the trees were attacked, of which half lost their leaders and 0.3% died. There was no indication that the infected trees had been weakened previously by drought or another pest, as many were among the tallest and fastest growing. The amount of damage per tree varied from slight twig dieback to death of two or three whorls to death of the entire crown.

Table 2 includes data on infection rate from both diseases. The data for *Dothistroma* are from Peterson and Read (1971) and are based upon composite samples of 1967 and 1968 needles, counted in 1968. The data for *Cenangium* were gathered in 1973 and are based upon counts of the number of infections per tree. Some of the counts are underestimates because it was difficult to determine whether two or more separate infections might have grown together in a case where a large portion of a tree crown was dead.

Two seedlots, 15-YUG and 23-AUS, stand out as being most resistant to both diseases. They suffered little enough needle mortality in Nebraska as to indicate that they could

Table 2. — Disease and insect damage to *Pinus nigra* seedlots at four plantations in north central United States.

Seedlot No. and origin	Disease damage: *Dothistroma pini*, NEB. % needles infected	Disease damage: *Cenangium ferruginosum*, MICH. infections per tree	Insect damage: Zimmerman pine moth, MICH. % trees attacked	Insect damage: Black-headed pine sawfly, MICH. & OHIO % trees attacked
2-SPA	76	1.0	15	30
3-SPA	88	1.4	26	40
7-ITA	48	3.0	21	50
10-FRA	—	2.3	35	32
13-FRA	—	3.6	29	0
14-FRA	—	1.4	17	20
11-COR	—	3.8	19	3
12-COR	88	2.9	3	4
23-AUS	14	.3	13	6
15-YUG	3	.1	4	26
16-GRE	—	3.0	5	8
17-GRE	30	.6	10	30
18-GRE	23	.5	13	19
19-GRE	48	1.9	19	18
20-GRE	31	.5	8	21
21-GRE	98	2.0	9	1
22-GRE	—	.4	11	13
24-GRE	31	1.6	6	7
25-GRE	—	.4	12	5
26-GRE	65	1.4	6	20
27-GRE	61	1.4	11	3
28-GRE	55	.4	13	19
29-GRE	—	2.5	9	2
8-CRI	56	.8	4	26
1-TUR	48	.6	3	6
4-TUR	58	1.4	16	14
5-TUR	49	1.8	30	9
Mean	50	1.5	14	16
F ratio for seedlot	4.6***	5.2***	1.6*	4.4***
Least significant difference among seedlots, 5% level	30	1.5	25	23

*, *** = statistically significant at 5 or 0.1% levels, respectively.

live indefinitely without spraying. In the Kellogg Forest plantation, damage was confined to dieback of an occasional lateral twig. Slightly lower levels of resistance to both diseases were found in three other seedlots (17-GRE, 18-GRE, 20-GRE) from northwestern Greece. At the other end of the scale some seedlots such as 3-SPA, 12-COR and 21-GRE suffered severe damage from both diseases. In Nebraska, their leaf area was reduced so much that heavy mortality would occur within a few years if control was not practiced. In Michigan, 25 to 40% of these trees became deformed as the result of damage to their leading shoots.

The similarity in attack patterns may mean that the trees' internal mechanism of resistance is the same for the two diseases. Whether or not that is so, it is fortunate from the practical standpoint that resistance to both diseases can be found in the same seedlots.

Insect damage. Damage due to insects was moderate. The most destructive insect was the Zimmerman pine moth *(Dioryctria zimmermani)* whose larvae feed on phloem and cambium, and whose presence can be detected by large pitch exudations. By 1973 this insect had attacked 14% of the trees in the two southern Michigan plantations. Most attacks resulted in death of one or two lateral branches; in a few trees the main stem was girdled and therefore became crooked. There were small (significant at 5% level only) genetic differences in susceptibility *(Table 2).*

The most common insect was the black-headed pine sawfly *(Neodiprion sertifer)* whose larvae feed on year-old needles in the early spring. Severe attackes result in reduced growth the following spring but rarely in mortality or poor stem form. This insect was present most years in the Ohio and two southern Michigan plantations. Damage counts were made in 1968 (Ohio) and 1973 (Michigan). As with the Zimmerman moth, there were significant genetic differences in levels of attack *(Table 2).*

Among the other insects causing noticeable damage was the European pine shoot moth *(Rhyacionia buoliana)* whose larvae feed on buds during the winter. At the Kellogg Forest in 1974 there were approximately 200 attacks, mostly on lateral shoots and of little practical consequence. The least attacked seedlots (significantly so) were 15-YUG, 11-COR, 23-AUS, and 25-GRE.

Seedlots which were least attacked by one of these insects included some which were lightly attacked and some which were heavily attacked by disease and other insects. In other words, the trees' internal mechanism of resistance to each insect and to the disease seemed to be different.

Taxonomic and Evolutionary Considerations

A search of three standard taxonomic references (Beissner, 1907; Elwes and Henry, 1908; Rehder, 1949) revealed that 85 different Latin names have been applied to *Pinus* *nigra* or its varieties. Most taxonomists agree that there are many fewer valid varieties but disagree on the limits and names of the varieties. Thus, the Crimean population may or may not be recognized as a variety (*P. n.* var. *caramanica* (LOUD.) REHDER); the Corsican population may be recognized as a separate variety (*P. n.* var. *poiretiana* (ANT.) SCHNEIDER) or may be grouped with Sicilian and south Italian black pines as *P. n.* var. *laricio* (POIRET) MAIRE; Greek trees may be considered as a part of Austrian pine (*P. n.* var. *austriaca* (HOESS) ASCH. & GRAEBN.) or included with Turkish and Crimean trees as *P. n.* var. *pallasiana* (LAMBERT) HOLMBOE. This list of inconsistencies could be expanded almost indefinitely.

In an attempt to straighten out the taxonomy, we combined data from the West German (RÖHRIG, 1966), New Zealand (WILCOX and MILLER, 1974) and present experiments. The three experiments sampled a total of 81 natural stands. The combination was done in an approximate manner by converting all measurement data to a percentage of the experimental mean. The major conclusions are as follow.

Corsican pine (*P. n.* var. *poiretiana* (ANT.) SCHNEIDER) is entitled to separate varietal status. In New Zealand, four Corsican seedlots grew fastest (107 to 110% of mean) and had the best stem form. They and some New Zealand stands of Corsican descent were the only ones recommended for planting. In West Germany and northern United States, Corsican trees were by far the slowest growing and least winter-hardy.

Trees from Sicily and southern Italy seem entitled to separate varietal status as *P. n.* var. *calabrica* (LOUD.) SCHNEIDER. In New Zealand they grew more slowly (95 to 107% of average) than Corsican trees and were mediocre in form (described by WILCOX and MILLER as "short and scruffy", "reasonable appearance", "steep heavy limbs", etc.).

Spanish trees are probably entitled to separate varietal status as *P. n.* var. *pyrenaica* (LA PEYROUSE) GODRON). In New Zealand, they grew at average rates (94 to 106% of average) and had very poor stem form ("atrocious", "gross malformation", "dead tops", etc.). In Michigan, they had 35% longer needles than most other black pines and were not quite as prone to winter damage as trees from France.

French trees (*P. n.* var. *salzmanni* (DUNAL) ASCH. & GRAEBNER) are also probably entitled to separate varietal status. When grown in Michigan they have 10% shorter needles (LEE, 1968) and somewhat more winter injury than Spanish trees. In New Zealand they grew at the same rates (93 to 111% of average) but had slightly better stem form than Spanish trees.

Cyprus trees grew so much more slowly than any others in New Zealand (54% of average) as to be entitled to separate varietal status but have not yet been named.

Trees from the remainder of the range (northern and central Italy, Austria, Yugoslavia, Albania, Greece, Romania, Bulgaria, Crimean SSR, Turkey) seem to constitute a single, rather heterogeneous variety (*P. n.* var. *nigra* or *P. n.* var. *austriaca* (HOESS) ASCH. & GRAEBNER). In New Zealand and Michigan their needles were sharper and 25 to 35% shorter than on trees from farther west. They grew faster than Corsican trees in West Germany and United States, slower than Corsican trees in New Zealand. Except on the coldest sites, all were winter hardy in West Germany and the United States.

There is a possibility of a north-south cline in this variety, as trees from Austria, Yugoslavia and northern Greece were noticeably more resistant to disease in Michigan and Nebraska than were most trees from farther south. Otherwise, however, it is difficult to differentiate the variety on a regional basis. The 13 Greek seedlots we sampled exhibited almost as much variation among themselves as was to be found in all seedlots from the eastern Mediterranean. In New Zealand, the range in growth rate was nearly the same for seven Yugoslav seedlots (78 to 104% of average), five Turkish seedlots (80 to 96% of average) and all eastern seedlots (78 to 104% of average) except the one from Cyprus. Tree form in New Zealand was about the same ("bushy", "heavy branches", "opossum damage") for Italian, Austrian, Yugoslav and Turkish trees.

Better taxonomic answers than these are desirable but will be difficult to obtain. Heavy cutting and planting make it hard to find true wild-type trees in some areas. The correspondence between varietal limits as set by studies of phenotypic variation and by genetic methods has been low. This indicates that even the most detailed biometrical studies of phenotypic variation would probably not give a true indication of the genetic variation pattern. Genetic studies of the type reported here are the best way to define varietal limits genetically, but they are so expensive that they must necessarily be practically oriented. Practically oriented future genetic work in any country likely to plant *Pinus nigra* in large quantities would probably be devoted to improvement in one or two specific traits (disease resistance in north central United States, disease resistance and growth rate in New Zealand, etc.), and such work would not be designed to provide taxonomic answers. For all these reasons it seems unlikely that we shall arrive at the ideal taxonomic classification of this species.

A few evolutionary generalizations can be made. The eastern half of the range is more continental and has colder winters than the western half; eastern seedlots show adaptation to those conditions by their greater winter hardiness. Also, eastern seedlots have the shortest needles. Corsica has a more oceanic climate than the continent, and Cosican trees were the least winter-hardy. Under mild but not under severe conditions they grow fastest. Trees from the southern, Peloponnesian Peninsula of Greece also exhibited adaptations to a mild climate; under Michigan conditions they suffered slight winter injury when young and as a consequence grew slowly.

The much disrupted natural range of European black pine is conducive to genetic drift, or the random fixation of genes of little or no adaptive value. Most of the natural stands are small or very small, and presumably have been so for centuries. Genetic drift may explain the lack of consistent geographic trends within *P. n.* var. *nigra*. For example, seedlots from northern Greece differed about as much from each other as they did from trees native to the Greek Islands in the Aegean Sea or Turkish trees. Genetic drift may also explain some interesting anomalies. For example, in *P. nigra* Spanish trees have the longest needles and are more winter hardy than trees from southern France. In *Pinus sylvestris*, native to higher elevations in many of the same mountains, Spanish trees have the shortest needles and are the least winter-hardy of any (WRIGHT *et al.*, 1966). In New Zealand, Sicilian trees grew 10% slower than trees grown from seed collected at the same elevation on Corsica, which is 5° farther north.

Practical Recommendations

Disease is such a problem in the growing of *Pinus nigra* in north central United States that disease resistance must be the primary consideration in making practical recommendations. From this standpoint, the following five seedlots (arranged in decreasing order of desirability) are the best.

15-YUG. Lat. 43⁰ 52' N, Long. 19⁰ 32' E, 900 m elevation, natural stand 16 km NW of Kremna, Yugoslavia.

23-AUS. Lat. 48⁰ 10' N, Long. 16⁰ 15' E, 500 m elevation, near Vienna, Austria.

18-GRE. Lat. 40⁰ 5' N, Long. 21⁰ 20' E, 1,300 m elevation, 31 km. W of Grevena, Epirus, Greece.

17-GRE. Lat. 40⁰ 20' N, Long. 22⁰ 20' E, 1,500 m elevation, Pieria Mountain near Katarine, Greece.

20-GRE. Lat. 30⁰ 50 ' N, Long. 21⁰ 3' E, 1,400 m elevation, Barko, Melia, Metsovo, Greece.

Within both Yugoslavia and Greece there is apparently a considerable amount of genetic variation among stands short distances apart. Therefore, if at all possible, growers desiring the best quality seed should specify that it be collected from as close as possible to one of the stands mentioned above.

Following the finding that seedlot 15-YUG was capable of thriving when others were decimated by *Dothistroma*, the U.S. Forest Service bought from commercial sources a considerable quantity of seed collected in the vicinity of that stand, grew the seedings, and released them to private growers in the Great Plains. That agency also used some of the seedlings to establish a seed orchard near Halsey, Nebraska.

For the long run, two other solutions are possible. One is to establish seedling seed orchards by practicing controlled pollination among the best trees of the most resistant seedlots. The other is to establish clonal seed orchards with the best trees in those seedlots. Both types of orchards are planned as soon as flowering starts in quantity.

Wilcox and Miller made other recommendations for New Zealand. Their best growth was obtained with trees grown from seed collected in old New Zealand stands of Corsican descent, so they can obtain seed orchards merely by thinning such stands. For those parts of New Zealand infested by *Dothistroma* the species can not be recommended, as only slow growing (by their standards) resistant types could live.

Acknowledgments

We wish to thank W. A. Lemmien and J. N. Bright for making many of the early measurements. Also, we wish to thank H. D. Gerhold, C. Hunt, J. W. Hanover, G. Peterson, S. K. Ries and K. Sink for reviewing the manuscript and offering many helpful suggestions.

Summary

A provenance test of European black pine was established in 1961 at five test sites in north central United States; it includes offspring of 24 natural and 3 planted stands. Mortality varied from 17 to 47% among plantations; most occurred the first two years. Height and other growth data are reported through age 15 from seed.

Results were similar in all test plantations. The fastest growing seedlots were from various parts of the eastern half of the range. Eastern trees were also winter hardy, except in northern Michigan. Trees from Corsica suffered severe winter injury; trees from France, Italy and Spain suffered less severe winter injury. In Nebraska a needle disease caused by *Dothistroma pini* and in Michigan a twig disease caused by *Cenangium ferruginosum* caused serious damage. In general., seedlots resistant to one disease were also resistant to the other; the most resistant were from Yugoslavia, Austria and northern Greece. There were also genetic differences in resistance to three insects.

Combined data from this provenance test plus others in West Germany and New Zealand indicate the species can be subdivided into six taxonomic varieties.

Key words: Pinus nigra Arnold, Provenance Tests, Deseases.

Zusammenfassung

Im Jahre 1961 wurden in den nördlichen Zentralstaaten der USA 5 Provenienzversuche mit *Pinus nigra* Arnold angelegt. Zur Auspflanzung gelangten 24 Herkünfte aus dem gesamten natürlichen Verbreitungsgebiet von Spanien bis zur östlichen Türkei und 3 Herkünfte aus Sekundärbeständen in Belgien und Frankreich.

Als schnellwüchsigste Provenienzen stellten sich solche aus dem ötslichen Teil des Verbreitungsgebietes heraus, die gleichfalls winterhart waren, ausgenommen auf einer Versuchsfläche im nördlichen Michigan. Abgesehen von der Winterkälte, wurden z. T. starke Ausfälle durch *Dothistroma pini* und *Cenangium ferruginosum* beobachtet, wobei sich Herkünfte aus Österreich, Jugoslawien und Nordgriechenland am widerstandsfähigsten erwiesen. Genetisch bedingte Unterschiede ergaben sich auch in der Resistenz gegenüber 3 Insektenarten.

Aus dem Vergleich der Ergebnisse aus diesen sowie anderen in Europa und Neuseeland durchgeführten Provenienzversuchen wird angenommen, daß die Art in 6 taxonomische Einheiten aufgeteilt werden kann.

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