THE FORESTRY POTENTIAL OF PINUS ELDARICA PLANTATIONS

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ABSTRACT

The forestry potential of *Pinus eldarica* Medw. (=*P. brutia* subsp. *eldarica*) is reviewed. *Pinus eldarica* is ideally suited to intensive silvicultural management directed toward the production of wood products in short rotations. Its rate of biomass accumulation rivals the fastest growing conifer species. Intensive culture will be required to optimize marketable products.

INTRODUCTION

Intensively managed forest plantations provide uniform wood products in short rotations. Man-made plantations can be harvested near processing plants, reducing costs associated with transportation and forest road building. Because short rotations provide an early return on investment, commercial forestry in the United States continues to focus on fast-growth silviculture. Less developed countries are forced to develop artificial plantations as they struggle to preserve their meager native forests and meet acute shortages of wood, fiber and renewable fuels. Essentially, man-made plantations reduce the need to harvest native stands protecting mountain watersheds.

The global interest in fast growth trees forces foresters to evaluate the potential of a given species, particularly exotics, against the ideal model, the intensive culture ideotype. The ideal species for a given region will be site-adapted, will show rapid juvenile growth and will have an indeterminate growth pattern that allows full use of the growing season. It will have an excurrent crown form, optimizing the utilization of growing space, and will produce acceptable wood products. Finally, it will be free of major insect and fungal pests. In examining the forestry potential of Pinus eldarica Medw. (more accurately identified as P. brutia subsp. eldarica), we will examine its attributes relative to those of the intensive culture ideotype.

GROWTH AND FORM

Fundamentally, P. eldarica is adapted to a wide range of growing conditions, making it an outstanding candidate for temperate arid zones. It tolerates temperatures from -25°C (-13°F) to 46°C (115°F), allowing it to survive a minimum to maximum temperature range of 59 C degrees. Because it is deep rooted and adjusts its growth to drought, P. eldarica can survive prolonged periods of environmental moisture stress, common to the Mediterranean region. Unlike most pine species it tolerates alkalinity, evidenced by its ability to grow well in soils having high concentrations of soil calcium carbonates. However, eldarica pine performs poorly when rooted in clay soils or when provided inadequate soil drainage.

Pinus eldarica occurs spontaneously from 200 to 600 m elevation only within a 550 ha area in a semi-arid steppe region in the Russian republic of Georgia (Tutajuk 1959, Zimina 1978). However, it is apparently adapted to the growing conditions of many countries where plantations have shown considerable promise. Successful introductions include:

N. Africa	N. Iraq	Turkey
S. Afghanistan	Israel	United States (1961)
S.E. Australia	N. Italy	Yugoslavia
France	Mexico	
Greece	Pakistan (1904)	
N.W. India	Portugal	
Iran (500 B.C.)	Spain	

The potential range of irrigated eldarica pine in the United States is determined by minimun temperature and soil texture (Fig.1). The occurrence of heavy soils combined with high rainfall restricts the tree's potential use in the Southeast to sandy sites, not identified on the map. The eastern boundary extending from Texas into Oklahoma marks the occurrence of Vertisols farther east having 30% or more clay in all horizons to a depth of 50 cm (Foth and Schafer, 1980).

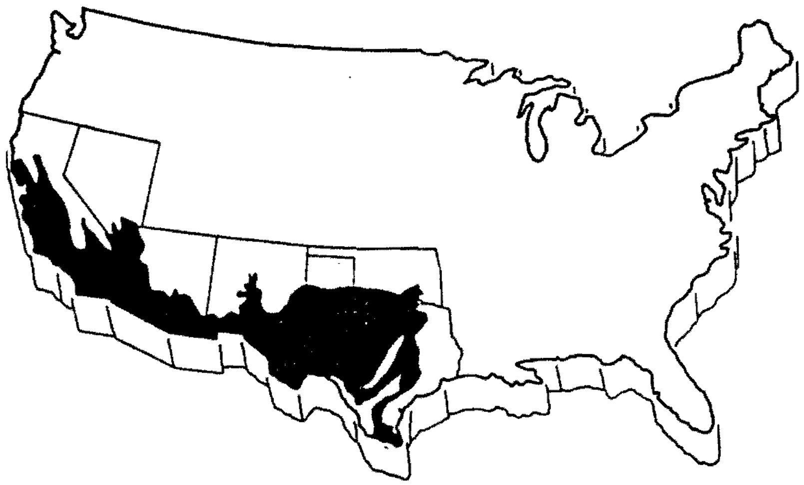

Fig. 1. Potential range of eldarica pine in the continental United States as indicated by darkened area.

Rapid juvenile growth and an indeterminate growth pattern make eldarica pine one of the most rapidly growing pine species. Figure 2 relates total annual terminal growth and number of days during which growth occurs in southern Russia to tree age. As the tree matures, use of the growing season increases to age four, remains constant for several years then declines slightly. The point of interest is that the growing season is fully utilized after the tree is well established, provided that water is not limiting. The pine has a similar growth pattern in southern New Mexico where branches elongate from mid-February to mid-November. In a provenance trial conducted in Las Cruces, New Mexico, juvenile eldarica pines from seven geographic seed sources consistently produced six growth flushes per growing season (Fisher, Neumann and Mexal, unpubl.)

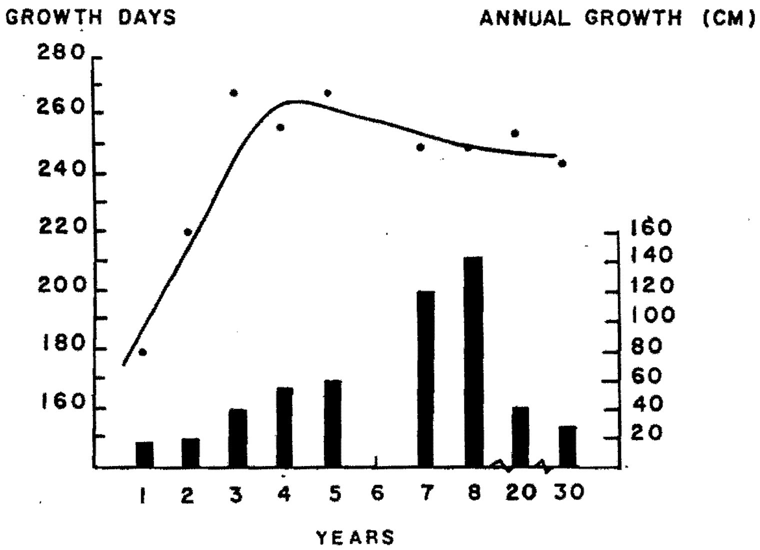

Fig. 2. Eldarica pine's mean annual terminal growth and utilization of growing season as a function of tree age. Adapted from data reported by Severtoka (1975), for plantations growing in Ashkhabad, Turkmenia.

Figure 3 illustrates the importance of moisture in maintaining rapid growth, and the ability of P.eldarica pine to respond better than P.brutia in southern New Mexico to supplemental irrigation. The lower curves, showing the cumulative growth of these species in southeastern Australia (Palmberg, 1975), suggest that P.brutia performs as well on a drier, more clayey site receiving less than 400 mm (16 in.) precipitation.

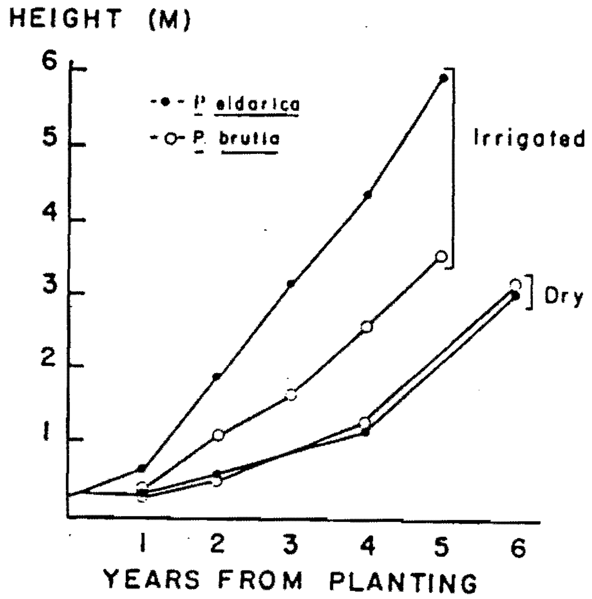

Fig. 3. Growth of P.eldarica and P.brutia on irrigated and "dry" sites, respectively in southern New Mexico and southeastern Australia.

Eldarica pine's ability to rapidly accumulate biomass rivals that of P.radiata and P.caribaea, possibly the most rapidly growing conifers in the world when they are grown intensively on productive sites (Table 1). In southern New Mexico, eldarica pine produced about 46 m^3/ha (657 ft^3/ac) of bole wood in five years when grown at a density of 1600 trees/ha (647 trees/ac) (Fisher, Neumann and Mexal, unpubl.). Drawing data from a limited number of trees, Fisher and McCrae (unpubl.) estimated dry matter production to be 108 t/ha (48.2 tons/ac) for irrigated trees stocked at 1372 trees/ha (555 trees/ac) and harvested six years after planting. Eldarica pine's crown form is excurrent which allows many trees to be planted per unit of land.

Table 1. Above ground biomass production of P. eldarica and other fast-growing species.

	Biomass (m.a.i.)	Age	Stems/ha	Country/Ref.
Temperate				
P. eldarica	18.0 t/ha	6	1,372	Southwest U.S
				Fisher & McRae (unpubl.)
P. radiata	23.4 t/ha	5-7	2,224	Australia
				Forrest & Ovington, 1970
" "	21.7 t/ac	4-8	1,500	New Zealand
				Madgwick et al., 1977
Tropical				
P. caribaea	17.5 - 21 t/ac	15	1,736	0-30 Lat. N&S
				Lamb, 1973

WOOD QUALITY

The acceptability of eldarica pine's wood products has not been explored in depth. However, there is sufficient information to predict which products will receive emphasis. Without silvicultural management, construction wood quality is low because the retention of numerous lower bole branches results in knotty lumber.

The mechanical properties of knot-free eldarica pine wood were recently determined at NMSU (Table 2). Space does not permit the discussion of test methods, or the relative importance of each property studied to wood quality. These are discussed at length by Haygreen and Bowyer (1982).

Table 2. Mechanical properties of juvenile eldarica pine wood as determined by NMSU preliminary tests conducted in 1985.

Test	Eldarica pine	Ponderosa pine	Hemlock
	---Species---		
Specific Gravity	0.49	0.43	0.35
Shear (g/cm^2 X 10–^{4})	11.9	8.9	7.4
Bending			
Maximum Strength (MOR) (g/cm^2 X 10–^{4})	79.48	74.05	62.36
Stiffness (MOE) (g/cm^2 X 10–^{6})	81.55	90.69	83.66
Compression parallel to grain			
Crushing strength (psi) (g/cm^2 X 10–^{4})	40.51	36.08	35.84
Stiffness (g/cm^2 X 10–^{6})	95.97	97.23	102.92
Compression perpendicular to grain			
Stress at proportional limit (g/cm^2 X 10–^{6})	7.48	3.26	2.4

For the sake of comparison, tests included two species valued for constructon lumber: hemlock and ponderosa pine. Eldarica pine wood specific gravity was relatively high (0.49), being comparable to values published for loblolly pine and exceeding those determined for hemlock and ponderosa pine. Because wood specific gravity greatly influences wood strength properties and yield (harvest weight per unit of land surface area), it is a measure often used to predict harvest value and utility.

Of practical importance is that stiffness parallel to the grain is low, indicating that lumber from ponderosa pine and hemlock is better able to resist elongation or shortening under tension or compression. However, eldarica pine has superior shear strength parallel to the grain and better compression strength perpendicular to the grain. Shear strength is related to the ability of of short beams to carry loads. Compression strength perpendicular to the grain is an important feature in designing connections between wood members in a building. Pulp tests conducted by Cellulosa de Chihuahua (unpubl.) and the Finnish Pulp and Paper Research Institute (1971) indicate that eldarica pine is clearly a candidate for paper pulp.

It should be emphasized that NMSU tests on mechanical properties involved juvenile wood exclusively. Fundamentally, wood quality improves as trees mature because wood specific gravity and cell length increase. In addition, longitudinal shrinkage and moisture content decrease.

All considered, eldarica pine produces several acceptable wood products. With approprite silvicultural management it is probable that the list of acceptable products will include building grade lumber. By planting trees on a close spacing, stem straightness is encouraged and the development of thick lower bole branches is discouraged. Many species, particularly fast-growing exotics such as radiata pine, are branch pruned as plantations are thinned. When a branch is removed from the bole of a tree, the sheath of new growth will eventually cover the stub, producing knot-free wood thereafter. Such wood has markedly higher value than knotty wood for solid wood products and veneer because of increased strength and improved appearance.

Figure 4 illustrates the strategy used to culture knot-free wood of exotic conifers grown in South Africa. The proportion of the lower crown removed increases as the tree grows. As much as 50% of the lower crown is removed when height reaches 30 ft. Essentially, pruning 25% of the lower crown has no measurable effect on subsequent growth. Removal of 50% of the crown reduces bole wood diameter growth slightly, and 75% removal reduces both height and diameter growth.

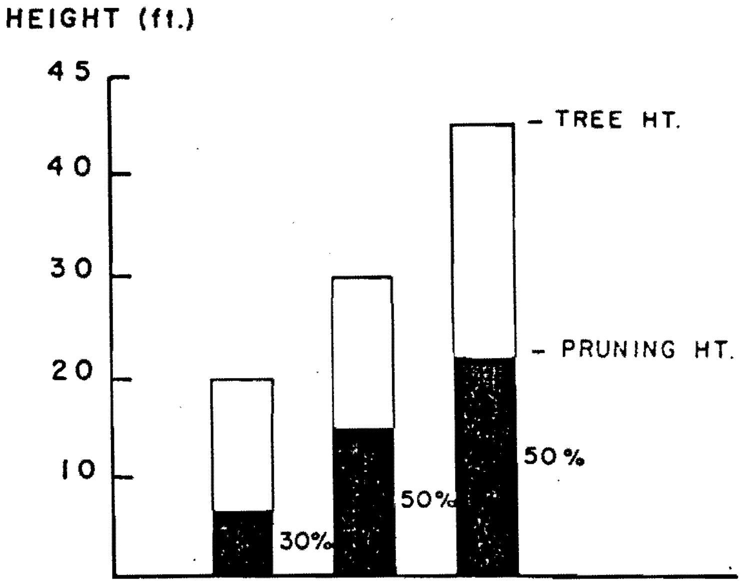

Fig. 4. Pruning height of exotic conifers in South Africa relative to total height.

GENETIC IMPROVEMENT AND PESTS

Product quality and yield can also be improved by genetic improvement. Among traits commonly selected for in tree improvement programs are wood specific gravity and fiber length. At the most elementary level, yield can be improved by selecting the right seed source. Studies conducted at NMSU detected sufficient growth differences among eldarica pine seed sources to justify efforts to utilize faster growing provenances. By choosing the highest yielding eldarica pine source included in our study over the lowest, production would be increased 60 percent (Fisher, Neumann and Mexal, unpubl.).

Eldarica pine has few pest- or disease-related problems. However, we anticipate more problems to occur as the tree is planted more extensively. In recent years, pine tip moth has caused minor injury in the Las Cruces area, but substantial problems in at least one Albuquerque plantation.

CONCLUSIONS

Eldarica pine is a fast growing species because it fully utilizes the growing season. Fast growth and the ability to tolerate alkalinity and environmental stresses make eldarica pine an outstanding candidate for arid zone plantations.

Based on the limited amount of work done in the United States, it seems probable that eldarica pine utilization will be limited to manufactured boards, paper pulp, fuel wood and extractives. Without intensive silvicultural management, wood appears inferior for building construction due to low bending strength.

It is probable that the geographic distribution of eldarica pine will increase and its attributes become better known. This especically applies to less developed countries where the production of fuel wood must be increased substantially over the next decade to mitigate projected shortages.

Considerable research is needed to optimize the quality and profits derived from plantations grown in the United States and abroad.

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