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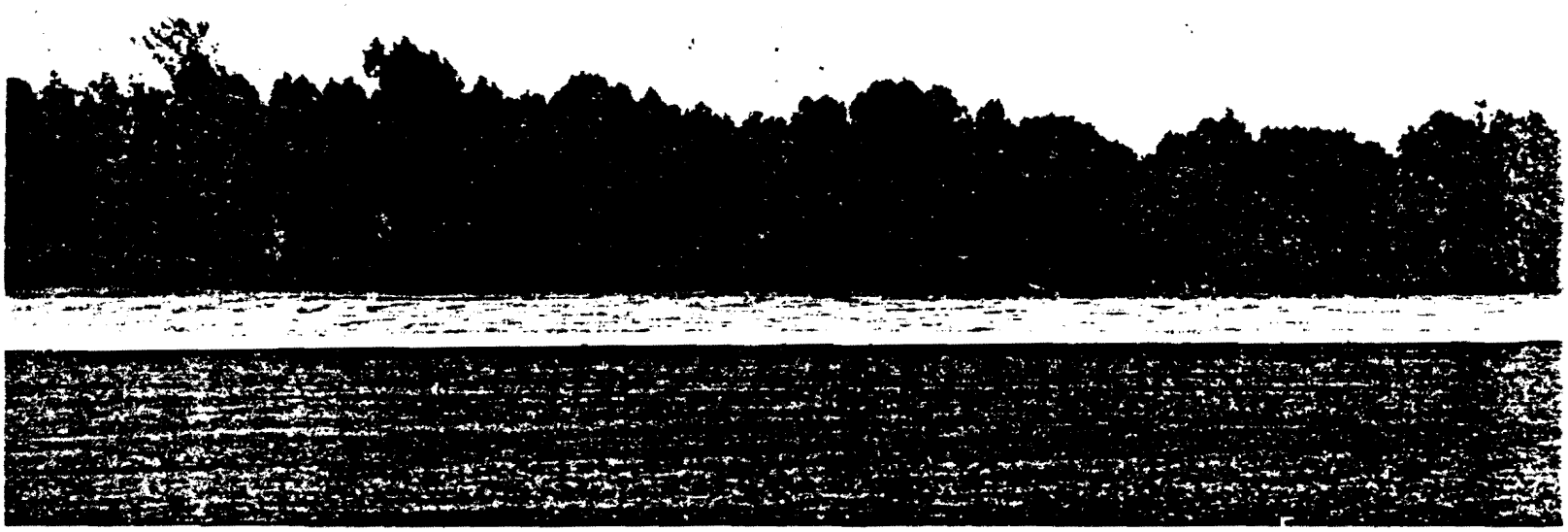

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AFGHAN PINE (*Pinus brutia* var. *eldarica*):

A Potential Shelterbelt Species for the Southern Great Plains

James T. Fisher and Fred B. Widmoyer[1]

A pine species introduced from southwest Asia more than 15 years ago has shown excellent survival, growth rate, and crown form in the Southwest. Tolerant of low rainfall, intense solar radiation, and alkaline soils, it is ideally suited to appropriate sites in the southern Great Plains. This area is bordered on the east by the 98th meridian, the west by the eastern foothills of the Rocky Mountains, the north by the Arkansas River, and south by a line extending the southern boundary of New Mexico eastward.

Introduction, Taxonomy and Natural Distribution

Present confusion concerning nomenclature necessitates mention of the introduction of the pine and its taxonomic affinities. In July 1960, J.R. Harlan, an agricultural explorer for the Crops Research Division, USDA, collected seeds of a pine in southern Afghanistan in or near the town of Laskargah, in the Helmand Valley (2). He was unable to identify the pine but was informed that the observed trees were probably grown from seed collected near Herat. His notes stated that the pine was: very fast growing; able to withstand very hot weather; planted extensively in southern Afghanistan; and might be grown for Christmas trees in the United States (7).

Seedlings subsequently grown at the Plant Introduction Station, Glen Dale, Maryland, were distributed to cooperators in the fall of 1961 (7). Stored seed provided a second distribution of seedlings in the spring of 1964.

Seedling recipients included F.B. Widmoyer, New Mexico State University, the Institute of Forest Genetics (U.S. Forest Service, Placerville, California), and the southern Great Plains Field Station (Woodward, Oklahoma).

The original collection was labelled P.I. 271431. A collection was made near Herat in 1965. Because it was not certain that this and the previous collection were from identical sources, a new number was assigned, P.I. 303638.

Taxonomy of what was subsequently called Afghan pine, Mondell pine, and Quetta pine has puzzled nurserymen and conservationists. Harlan omitted species (*Pinus* spp.?), making no serious attempt at classification. H.H. Fisher stated that collection P.I. 271431 had been identified *P. halepensis* Miller. This seemed to support J.E.T. Aitchison's 1881 record of a collection of "*Pinus halepensis*" (Aleppo) pine in Afghanistan (2).

However, it is our view that W.B. Critchfield's classification of the pine as *P. brutia* var. *eldarica* provides the clearest interpretation (2). He reported that "the low elevation pine of Afghanistan is a cultivated race belonging to the *P. brutia* group". He added that it is probably derived from *P. eldarica*, itself a subspecies or variety of *P. brutia* via Persia, where it has been cultivated for several centuries. Available to Critchfield were herbarium materials, living specimens of P.I. 271431, and information filed on its cone, seed and shoot characteristics. Frederick Meyer, taxonomist,

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[1]Assistant Professor of Silviculture and Professor of Ornamental Crops, Horticulture Department, New Mexico State University, Las Cruces.

U.S. National Arboretum, concluded in 1971 that the Afghanistan pine was not P. halepensis.

Throughout this paper, Afghan pine and P. eldarica should be considered synonomous with P. brutia var. eldarica. P. eldarica is used when necessary to cite research reported under that name. Russian scientists and foresters working for the United Nations in southwest Asia refer to P. eldarica Medw.

Overlap of natural ranges, natural hybridization, and absence of distinct foliage differences make separation of P. halepensis and P. brutia difficult in some areas (16). The P. halepensis/brutia complex thus receives considerable reference. The complex belongs to the subgenus Pinus, section Pinus, and subsection Sylvestres (4). In addition to the major species, P. brutia contains variants P. eldarica and P. pithyusa (4).

Present ranges of pines in the Mediterranean area have derived from nature but also from great disturbances caused by man's excessive utilization, fire and domestic animals. Distributions are as follows: P. halepensis is the most widely distributed pine of the Mediterranean region and ranges from eastern Spain through France and Italy, to the Adriatic coast of Yugoslavia, and to Greece, Turkey, south to Jordan and Israel, then westward to Libya, Tunisia, and Morocco. P. brutia replaces P. halepensis for the most part in the eastern Aegean region, Turkey, the Islands of Crete and Cyprus, and in the Black Sea region. Ranges of the two overlap in northeastern Greece, where they hybridize, in southeastern Turkey, and a few other isolated areas (4,16).

In the Black Sea region are P. eldarica and P. pithyusa where the latter grows along the northern and northeastern shores of the Black Sea. P. eldarica, considered an Oligocene relic, is confined to a single low mountain in a semi-desert environment southeast of Tbilisi, Georgia, Transcaucasia. It grows along the eastern extremity of the Choban-Dagh Range, along the south side of the Iori River and occupies only 1400 acres (550 hectares).

In accordance with Critchfield, the Afghan pine should be classified as a variety or subspecies of P. brutia. This is justified by morphological and chemical difference within the complex. P. brutia generally has a straighter stem, finer branches, larger branch angles, and wider needles than P. halepensis. However, all but cone and seed characteristics seem to break down in areas of overlap (16). P. halepensis cones are stalked and reflexed, whereas P. brutia cones are sessile, or nearly so, and projecting. Also, P. halepensis cones usually occur singly or in pairs on branches, whereas three or four cones form whorls on P. brutia branches. Highly useful to seed idientification is the striking difference in seed size between the two species (2). P. halepensis seeds are much smaller, 29,000 seeds per pound as compared to 11,000 seeds for P. brutia. Much of the uncertainty of species identification can be attributed to the absence of cones in herbaria.

Terpene chemistry provides another means for identification. The terpene 3-carene is absent in P. halepensis but is present in P. brutia and its variants (14).

Afghan pine has the widest needles and fewest needle resin canals within the P. brutia group (2). Seed size can also be used for its identification since it has the largest within the complex or P. brutia group, 6,500 seeds per pound. Morphological characteristics of P.I. 271431 grown at Las Cruces support Critchfield's classification as P. brutia var. eldarica. The species is almost certainly not P. halepensis.

Growth, Adaptation to Arid Zones, and Multiple Uses

Rapid growth rate, crown form, and ability to grow under low rainfall and on alkaline soil make Afghan pine an excellent shelterbelt species for portions of the southern Great Plains. Its attributes, environmental requirements, and multiple uses are as follows.

The P. halepensis/brutia complex is subjected to a Mediterranean climate in most of its range. This features modest precipitation in the winter season, and warm to hot summers receiving little rainfall for as many as 6 to 7 months. Heth (11) attributed the ability of P. brutia to withstand such extremes to strong lateral and deep roots, and a marked decrease in transpiration and cell solute potential under low moisture supply. Afghan pine has similar growth and physiological characteristics and has been described as very drought resistant species suited to afforestation of dry mountain slopes in Russia (5). Noteworthy is the modified tap root system, comprised of numerous deep vertical roots with extreme lateral root development. Prolific root regeneration potential facilitates rapid penetration of deep moisture-containing soil layers.

Recently studied were germination and subsequent radicle extension of P. eldarica and P. ponderosa subjected to substrate water potentials ranging from 0 to -20 bars (5). P. eldarica seeds germinated as low as -12 bars; ponderosa pine failed to germinate below -8 bars. Optimum levels were -4 and -2 bars. The ability of P. eldarica to germinate at lower potentials suggests a greater degree of adaptation to arid conditions. Palmberg (15) stated that genotypes with large seeds are favored in adverse conditions, such as low rainfall or low winter temperatures. P. eldarica is subjected to both under natural conditions and has the largest seed of the P. brutia group.

F.B. Widmoyer recently witnessed the wide use of Afghan pine for reforestation of devastated land in Pakistan. Drought resistance has made P. eldarica a suitable alternate to P. radiata in Australia on dry sites (15). It is shade intolerant (9) and is ideally suited to the arid Southwest, where in some areas pan evaporation exceeds precipitation five times. It must be emphasized, however, that survival and growth will be less without supplemental irrigation under conditions of low rainfall (less than 15 inches, or 375 mm). For example, trees planted on the ocean side of southern California mountains grew 24 feet after 8 years, whereas only 18 feet of growth was recorded for the drier, lee side in the same period (3).

Total moisture received by Las Cruces experimental trees is 20-24 inches (500-600 mm) per annum, 12 inches from three or four irrigations, 8-12 inches from natural precipitation. Trees planted at Woodward in October, 1961 in a fine sandy loam were initially irrigated and have subsequently received about 23 inches (575 mm) natural precipitation yearly (10).

Although members of the P. brutia group are more frost hardy than P. halepensis, hardiness is not sufficient to permit Afghan pine afforestation throughout the southern Great Plains. Seedlings planted in southern California; Sedona,Arizona; Lubbock, Odessa, Amarillo, and Knox City, Texas; and Woodward, Oklahoma have survived and produced good growth. Seedlings planted in New Mexico below 4800 feet have responded similarly. However, numerous trees planted above 5000 feet in Albuquerque were injured or killed by a severe freeze in 1976. One hundred percent mortality was recorded at elevations above 7000 feet at Mora, Espanola, and Taos, New Mexico.

Because Afghan pine has survived more than a decade at Woodward and Las Cruces, the climates of these two sites can be used to estimate minimal temperature and growing season requirements. Days without frost are 208 and

198 days respectively, with minimum temperatures as low as -8°F. Maximum temperatures have exceeded 106°F at both sites. Areas having 200 frost free days, winter minimum temperature above -8°F and maxima below 106°F should be suitable for planting. Within New Mexico, Texas, and Oklahoma, USDA Plant Hardiness Zone 7 should provide a reasonably safe boundary.

Planting sites within Zone 7 must have a porous soil texture since Afghan pine does poorly in soils with low oxygen tension. Clayey or excessively watered soils are not suitable (11) and point clearly to the porous limestone and sandstone soils naturally supporting Afghan and Aleppo pines (1,8).

Significant is Afghan pine's tolerance to alkaline soils, common to the southern Great Plains and a serious problem to afforestation with conifer species. Ponderosa and Scotch pines are severly affected in southern New Mexico and commonly show chlorosis and stunted needle development. P. halepensis has been successful in these areas but lacks crown form suited to wind protection.

Afghan pine has shown excellent growth rate and form in southern New Mexico. Maximum height of closely related P. brutia is about 100 feet (30 m) under natural conditions (9). Afghan pines have reached 50 feet in less than 15 years in Las Cruces. Plantations reach 6 feet within three years and add an additional three feet each following year. Woodward trees averaged 31 feet and 16 inches (40 cm) diameter in July, 1978, almost 17 years after planting (10).

Afghan pine produces a single trunk and retains its lower branches. Its stem is straighter and branches finer than P. halepensis, especially under moderate to good soil depth and moisture (10). Compact crown form and lower branch retention provide an effective and lasting wind barrier.

Multiple uses include Christmas trees, fuel wood and possibly pulpwood. Commercial Christmas trees are being grown in Arizona and West Texas. Growth rates at Las Cruces would set rotation cutting of 3 years. Because a large portion of 5-6 feet (1.5-1.8 m) trees are fairly compact, selection of desirable individuals should minimize shearing. Lumber is inferior to New Mexico commercial timber species but fast growth rate may provide fuel or pulpwood. Under favorable conditions, P. brutia annually produces 86 cubic feet of wood per acre (6 m^3/hectare/year). This is almost three times growth rates of southern Rocky Mountain timber species. According to the Finnish Pulp and Paper Research Institute (6), high quality sack paper can be made from P. brutia pulp (Turkey source). It had lower tensile and burst strength than Scotch pine, but superior tearing strength. Wood properties were reported as follows:

Wood density	mean 0.542 ± 0.013 kg/dm^3
Fibre length	weighted average length 2.95 mm
Fibre width	0.041 mm
Fibre cell wall thickness	0.0081 mm

Seedling Production and Afforestation

Production begins with procurement of foreign seed or seed collection from the small number of cone bearing plantations growing in the Southwest. Dysgenic selection of native sources makes selection of proper seed source critical to success. Frequently reported are failures due to mislabelling of P. halepensis as Afghan pine. An international provenance study is underway at Las Cruces to identify superior species and provenances within the P. halepensis/brutia complex. Cooperating in this project are state, federal and university

personnel.

Early seed production makes Afghan pine an ideal species for seed orchards and tree improvement research. It produces ovulate cones by age 4 from seed and these mature in 3 years. Serotinous cones (7 cm) are produced yearly. In Las Cruces, seven year old trees produced a prolific staminate cone crop which released pollen beginning late March.

Mature cones can be collected in mid-summer. Kiln or solar drying will be required to extract seed. Kiln drying requires 130°F and 35% relative humidity. Prior to drying, live steam should be introduced to the kiln for 10 minutes (13).

Seed germination is generally 70-90% if empty seeds are removed by floatation, 70%, otherwise (1). Laboratory germination has required 5-15 days (5), seedbed germination has required twice as long (13). Because temperatures above 77°F induce dormancy in related species, this should be considered an upper limit until more data becomes available on Afghan pine.

Uncertain identification of foreign seed or need to multiply desirable genotypes may justify vegetative production. This would take advantage of the latent capacity of dwarf shoot meristems to produce new succulent shoots following removal of long shoot terminal buds. Cuttings from young succulent shoots are rooted more easily than are those taken from older shoots. Developed for P. radiata and presently receiving substantial exploration, this technique may be useful in Afghan pine production (LeRoy Johnson, U.S. Forest Service, Region 3)

Containerization is commonly employed to produce seedlings for afforestation in arid zones (9,12) and has been highly successful with Afghan pine. Under greenhouse conditions Afghan pine seedlings have grown faster than native commercial timber species. Seedlings grown in 10-cubic-inch book planters or polyethylene tubes showed excellent survival following late February or mid-October planting in southern New Mexico.

Insect, Diseases and Physiological Disorders

No serious insect or pathological problems have been noted in Las Cruces plantations. Plantings elsewhere have developed limb rusts (Peridermium spp.). Seedling chlorosis has been noted in Israel and has been attributed to absence of a mycorrhizae forming fungus (Boletus granulatus) in nursery soil. Trees planted near Los Angeles and along the Aspshron peninsula (Russia) in an industrial zone have not shown smog injury. Excessive watering or clayey soils will cause severe problems and should be avoided.

Conclusions

The pine introduced from southern Afghanistan should be referred to as the Afghan pine. Recommended nomenclature is Pinus brutia var. eldarica. Because of its tolerance of low rainfall, high temperatures, and alkaline soils it appears suited to areas of the southern Great Plains, especially southern New Mexico. Its excellent growth rate and form should make it an outstanding shelterbelt tree under suitable climate and soils.

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