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THE INTRODUCTION, PERFORMANCE AND STATUS OF *PINUS HALEPENSIS P. NIGRA* AND *P. PINEA* IN SOUTH AFRICA

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Abstract

Mediterranean pine species have been planted in the Cape Colony from the beginning of European settlement in South Africa. One of the first introduced was P. pinea (XVI century) followed later by P. halepensis (early XIX century) and P. nigra (late XIX century. P. pinea and P. halepensis performed relatively well under harsh conditions of dry and cool climate. In stands, they could grow to almost 30 m in height. Since the beginning of the XX century, the two species have not used for commercial tree planting any more because their growth is slower compared to other pines. They remain, however, important in landscaping in towns and cities as well as in tree planting projects on farms.

EARLY INTRODUCTION OF PINES TO SOUTH AFRICA

Two Mediterranean species of pines were almost certainly introduced in the Cape during the years 1685 to 1693, this is shortly after the arrival of Europeans under the command of Jan van Riebeeck. They were *Pinus pinaster* brought under the name of *Pinus silvestris* and likely *Pinus pinea* referred at the time as *Abies* (Shaughnessy, 1986). First records of their performance are provided by Kolb (1719 in: Shaughnessy, 1986) who described three specimens of the two species growing in the Company's Garden, currently the Cape Town Public Gardens in the centre of the city. By 1772, *P. pinaster* was widespread in the area, and by 1810 both *P. pinaster* and *P. pinea* became common features of Cape Town and surrounding lands. The first attempts to plant *P. pinea* in the Eastern Cape failed when the species was planted in Cathcart in 1877 (Darrow, 1973).

The earliest (1857) records of *Pinus halepensis* came from a farm near Caledon east of Cape Town (Smith, 1857). There were rows of trees of all the three pine species estimated to be about 30 years of age. This means that *P. halepensis* could have been introduced to South Africa before 1830. The variety *brutia* was introduced to South Africa in 1938 (Poynton, 1977).

Pinus nigra var. *nigra* was brought to South Africa not later than 1883, when seedlings of this species (recorded as *Pinus austriaca*) were produced in the Tokai nursery (Poynton, 1977). A year later, the variety *maritima* was recorded as *Pinus laricio* in the Eastern Cape inventory, while in 1891, var. *cebennensis* (under the name *Pinus salzmannii*) was raised in the nursery at Tokai (Poynton, 1977).

By 1858, early research results showed that *P. pinaster* and *P. pinea* were the most promising pines in the Cape and that *P. halepensis* and *P. radiata* were also recommended for planting for economic gains. Pines were found to perform well in areas without indigenous forests and therefore they were recommended for afforestation for fuel, construction materials, shelter and aesthetics. Therefore pine seeds were distributed to the public for commercial afforestation. Besides the commercial needs, the afforestation around Cape Town was justified on the principles of improved water management, preventing fires common in macchia-type fynbos vegetation, and for improving aesthetics of otherwise “bare and stony slopes” (Conservators of Forests, 1893 in: Shaughnessy, 1986).

SILVICULTURE AND PROTECTION

The first prescribed silviculture involved a high level of disturbance of indigenous vegetation consisting predominantly of fynbos. It was recommended to burn the vegetation and follow with ploughing, cross-ploughing or digging of pits on steep slopes. Original concept of planting seedlings was soon replaced with seeding at a density of 50 to 100 kg/ha, while today 6 kg/ha would be considered sufficient (Hutchins, 1893 in: Shaughnessy, 1986). Between 1882 and 1893, farmers in the region were

supplied with one million seeds of *P. halepensis* (and 34 million *of P. pinaster*)(Shaughnessy, 1980). Between 1883 and 1914, 35 *P. halepensis* seed shipments, amounting to 10,5 t, were ordered from merchants in Austria, France, Italy and Spain. Systems of prizes were introduced to award farmers for best plantations of forest trees. From 1892, *P. halepensis* and other exotic species were planted in buffer zones to protect indigenous forests against fire (Geldenhuys *et al*., 1986).

In 1939, Craib published his pioneering work on silviculture and management of fast growing plantations in South Africa. He included information specific to *P. pinaster* but not the other Mediterranean pines (Craib, 1939; 1947). This means that already after the World War I, *P. halepensis*, *P. nigra* and *P. pinea* were not considered as the major pines for commercial afforestation. Wherever the other Mediterranean species were planted, they were treated in a similar way to *P. pinaster*.

Silvicultural investments in the Mediterranean pine plantations are not high due to their slower growth and less desired timber properties (Zwolinski and Hinze, 2000). The current trend is to minimize soil tillage: for tree planting, soil is usually hand-pitted to 20-30 cm depth and at 35-50 cm diameter. Weeds are controlled by hand slashing and hoeing, or with herbicides in 1 m diameter spots around planted trees. Usually 1372 trees per hectare are planted at spacing 2,7 x 2,7 m. Their numbers are reduced in thinning operations to 800 trees/ha at 10-12 years and further to 500 trees/ha at 15-17 years. Fertilization of Mediterranean pine stands is usually not practiced as the species are planted on dry and marginal sites with negligible impact of fertilizer on their performance. Once established, trees may be pruned to 7,0 or even 9,0 m where quality logs are expected.

PERFORMANCE OF PINES IN EXPERIMENTAL STANDS

Experimental plots of *P. halepensis*, *P. nigra* and *P. pinea* have been established all over the southern African region, under diverse climate and soil conditions (Poynton, 1977). Their location within the Republic of South Africa is shown in Figure 1 while the range of growth conditions are provided in Table 1 (Mark Horan, University of KwaZulu Natal, pers. comm., 2005).

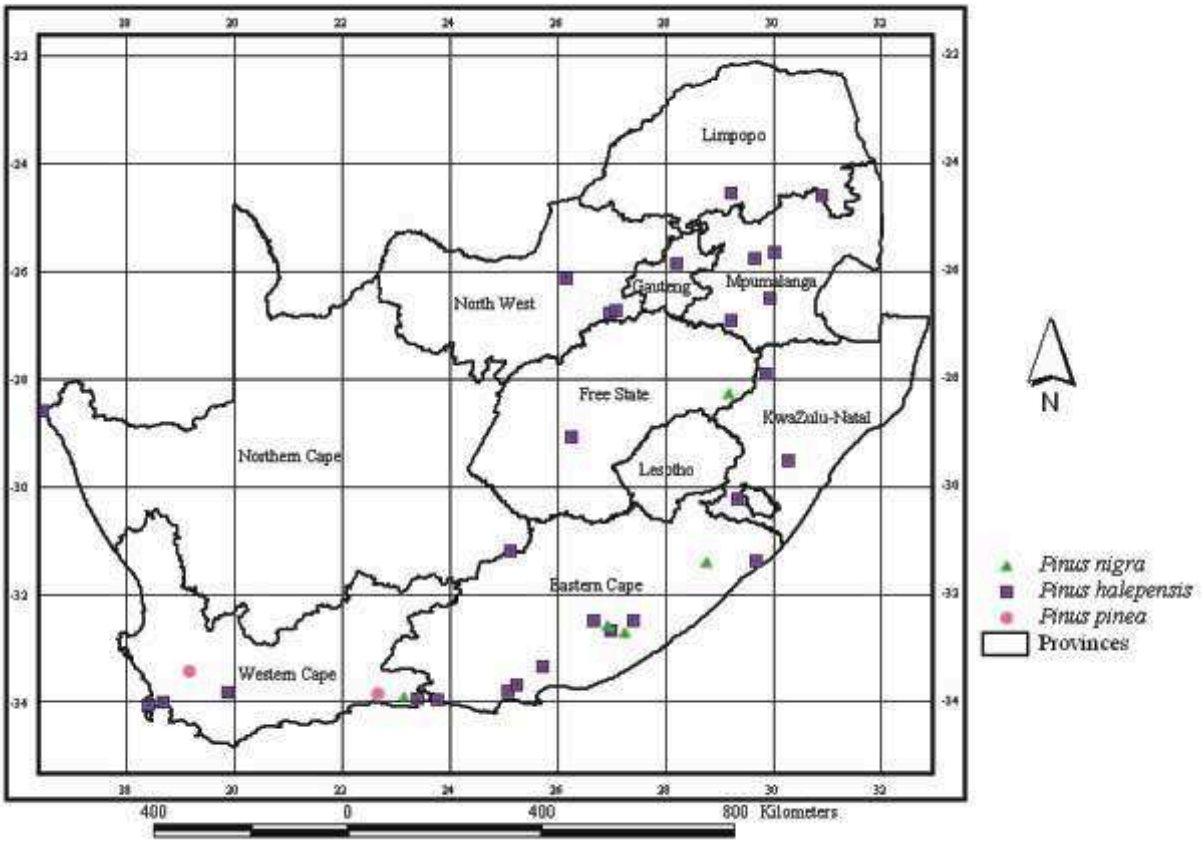

Fig. 1. Location of experimental plots of three Mediterranean pine species in South Africa.

Table 1. Characteristics of extremes in location and some growth conditions of experimental plots of the three Mediterranean pines introduced in South Africa.

Latitude		Longitude		Altitude (m)		Mean Annual Rainfall (mm)		Mean Annual Temperature (°C)	
min.	max.	min.	max.	min.	max.	min.	max.	Min.	max.
24,57	33,97	16,47	30,90	28	1901	315	1401	12,9	19,0

Height growth of the three pine species is shown in Figures 2-4. A simple regression (y=ax+b) was used to show trends in growth of the three pine species. Within the limited number of experimental plots, the fastest growth characterized *P. halepensis* and *P. pinea*, with a slope of the regression a=0,30, compared to a=0,22 for *P. nigra.*

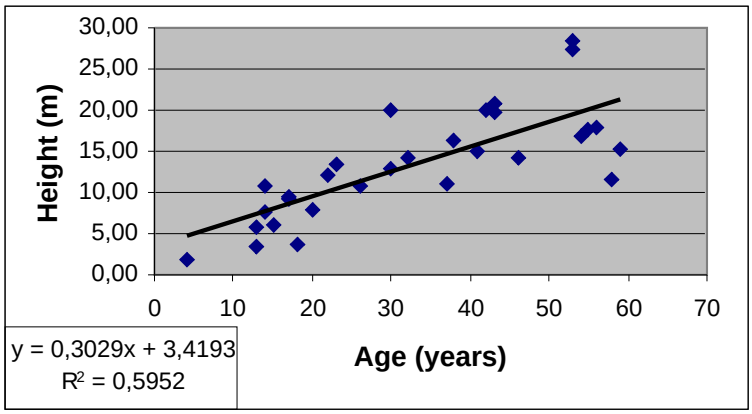

Fig. 2. Height growth of *Pinus halepensis* in experimental plots in South Africa (adapted from Poynton, 1977).

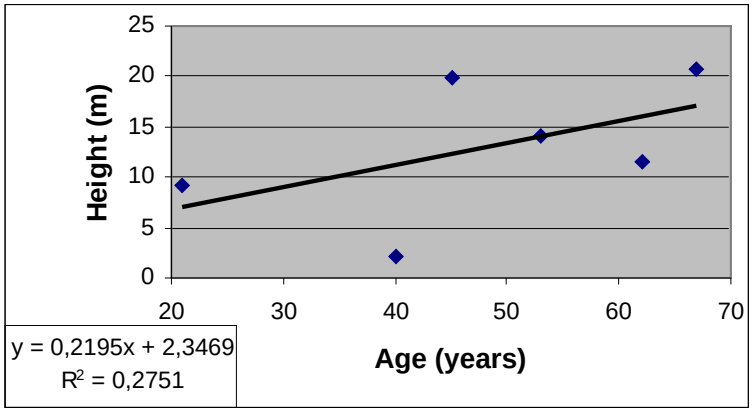

Fig. 3. Height growth of *Pinus nigra* in experimental plots in South Africa (adapted from Poynton, 1977).

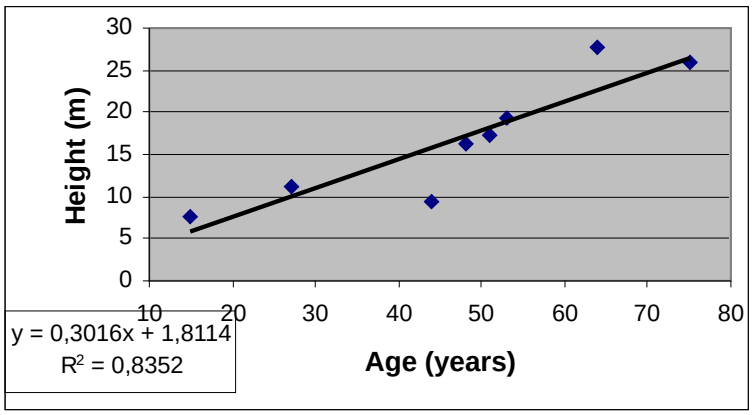

Fig. 4. Height growth of *Pinus pinea* in experimental plots in South Africa (adapted from Poynton, 1977).

Based on 41 experiments of *P. halepensis*, six of *P. nigra*, and eight of *P. pinea* (Poynton, 1977), the following conclusions can be formulated:

1. at the age of 53 years, *Pinus halepensis* grew up to 28,3 m in height and 38 cm in diameter at breast height (dbh) on deep sandy loams in areas with mean annual precipitation of 932 mm and at stand density of 247 trees/ha. The species performed relatively well in the winter rainfall area (Western Cape) and in the drier parts of the country (Orange Free State). It failed in mist belts of KwaZulu-Natal but grew relatively well in parts of the eastern highveld (Gauteng Province) and the lowveld (Mpumalanga and Limpopo Provinces). Currently the species is not used for commercial afforestation due to its slow rate of growth. It is, however, one of the most useful species for planting on farms for shade, shelter and woodfuel in the drier parts of South Africa;

2. *P. nigra* stands grew to about 20 m in height and 36 cm in dbh at 45 years of age. The best performing trees were planted in the mountains of the Eastern Cape Province (summer rainfall area) at altitudes between 900 and 1800 m asl. Due to poor performance, the species is not considered for further trials or commercial planting in the country;

3. in closed canopy stands, *P. pinea* achieved heights of 27,7 m and dbh of 60 cm at 60 years of age. Individual trees in the Cape Town area grew to 35 m height and 185 cm dbh. Almost all trees, however, forked from 3 m above ground (Figure 5). The species performed best in the winter and uniform rainfall area (Western Cape and parts of the Eastern Cape Provinces). In the eastern part of the highveld (summer rainfall area) the species proved exceptionally hardy to frost and drought. Unfortunately, with a trend to eradicate alien vegetation, *P. pinea* stands little chance to be used as an ornamental species despite it still being a part of urban landscapes in Cape Town and in the Western Cape Province. It cannot be considered for timber production as its growth and form are inferior when compared to other pine species.

Performance of the species in other southern African countries has been studied across the region, from Angola to Mozambique and Lesotho (Poynton, 1977). Nowhere, however, these species showed promise as plantation trees, their growth was slow and form very poor. The only exceptions may be found in Lesotho, where *P. pinea* and especially *P. halepensis* showed to be hardy to frost, with the latter species surviving even at 2377 m asl.

Site indices for 20-yr-old stands (SI_{20}) were calculated based on growth model for *Pinus pinaster.* Despite it is another species, there are growth similarities and the use of a site index model developed by van Laar (1985) for *P. pinaster* was recommended (Heyns Kotze, KLF Research, pers. comm., 2005). This SI_{20} was used to see if there is any relationship with growth conditions. There has been a tendency for *P. halepensis* and *P. pinea* to decrease SI_{20} with increasing altitude (J. Zwolinski, unpublished data, 2005), while the optimum altitude for *P. nigra* was established at 1400 m asl (Figure 5).

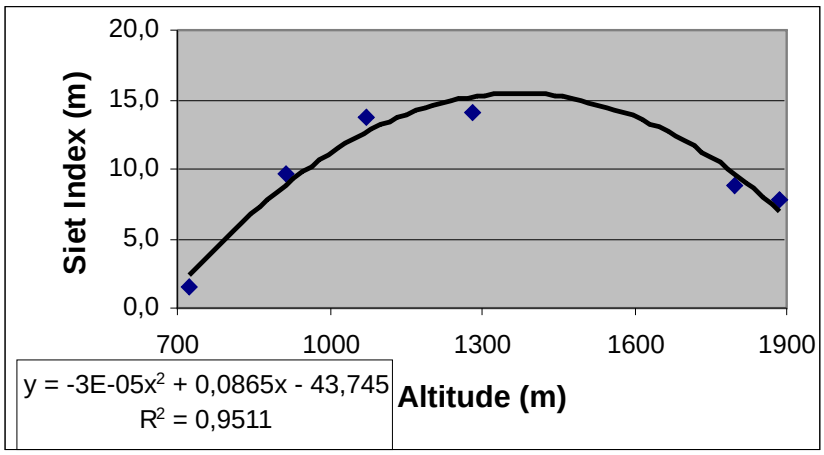

Fig. 5. A relationship between altitude and site index for *Pinus nigra* in South Africa.

Also *P. halepensis* and *P. pinea* showed optimum performance in relation to rainfall with best sites receiving between 1000 to 1200 mm annual rainfall (Figure 6). On contrary, the SI_{20} of *P. nigra* continued increasing with increasing rainfall (J. Zwolinski, unpublished data, 2005).

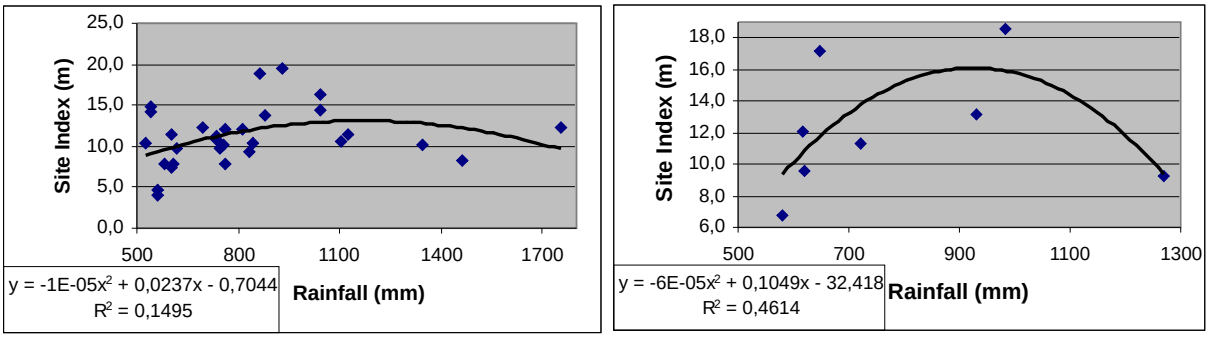

Fig. 6. Relationships between Site Index and rainfall for *P. halepensis* (left) and *P. pinea* (right).

CURRENT PLANTATIONS

Despite that *P. pinea* and *P. halepensis* occur commonly as ornamentals in streets, gardens and parks in South Africa, their use for timber production has been discontinued due to its slow growth, poor form and inferior timber. This is especially true for *P. pinea* which forks commonly at a height of about 3 m (Figure 7).

Fig 7. *Pinus pinea* stand near Cape Town.

The form of *P. halepensis* is also poor. This is mainly due to a tendency of this species to lean what results in compression wood. *P. halepensis* is also very sensitive to fire damage. When affected by hail, the tree becomes easily infested by *Sphaeropsis sapinea*, a pathogen responsible for top dieback and stunted growth. Also *Pineus pini* (Adelgideae) is one of many destructive pests of this species.

Despite that today, all the Mediterranean pines lost their importance in commercial forestry in South Africa, they have been well studied, selected and bred. They form interesting populations and should be included in international conservation programmes. The most superior genotypes could be used in commercial afforestation projects worldwide.

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