

DENDROCLIMATOLOGY OF UMBRELLA PINE

(*Pinus pinea* L.) IN ISTANBUL, TURKEY

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ABSTRACT

To determine the response of tree rings to climate, twenty cores were extracted from ten trees of *Pinus pinea* L. in Istanbul-Alemdağ. A response function was used to characterize the relationships between tree rings and temperature and precipitation. The precipitation of the current year and the temperature at the beginning of the growing period have a significantly positive influence on the growth of the tree ring. Mean sensitivity was found to be 0.291, and it was concluded that *Pinus pinea* L. is a dendroclimatologically sensitive species.

INTRODUCTION

Pinus pinea L., which attains its widest distribution in Turkey, naturally grows in the Mediterranean, Aegean, and Black Sea regions from sea level to 1000 m. Since the last quarter of the nineteenth century, this species has been cultivated on the both sides of the Bosphorus' waterfronts and in private gardens. Genova (1986), Gutiérrez (1989), Richter et al. (1991), and Akkemik (1995) pointed out that precipitation has an important positive influence on the ring widths of pine species. Cherubini (1993) concluded that precipitation plays the most important role on the growth of tree rings of *Pinus pinea* L. Perez-Antelo and Fernandez-Cancio (1992) stated that *Pinus pinea* L. can be used for dendroclimatic analysis. This research was carried out to determine the relationships between tree rings of *Pinus pinea* L. and climatic records.

MATERIALS AND METHODS

Using a Swedish increment borer, 20 cores were extracted at a height of 1.30 m from ten trees of *Pinus pinea* L. in Istanbul-Alemdağ. The sampled trees are healthy and more than 100 years old. The sampling site is at latitude 41°08' N and longitude 29°04' E, is 70 m above mean sea level, and has a western exposure and a slope of ten percent. Parent material is granite, and the soil type is sandy clay (Kantarci 1987). The site is under the submediterranean climatic condition, with a mean annual precipitation of 827.6 mm. According to the Thornwaite method (Çepel 1988), climate type is humid, mesothermal, and there is a serious water deficiency in summer and a serious water surplus in winter.

The site has a complex flora composed of macchie elements such as *Laurus nobilis* L., *Quercus coccifera* L., *Arbutus unedo* L., *Phillyrea latifolia* L., *Cercis siliquastrum* L., *Erica arborea* L., *Spartium*

junceum L., and *Pistacia ssp.* and Euxine elements such as *Quercus petraea* (Mattuschka) Liebl., *Q. robur* L., *Tilia argentea* Desf., *Similax ssp.*, and *Hedera ssp.* In addition, *Pinus brutia* Ten. and *Pinus pinea* L., which are Mediterranean region trees, grow rather well.

Before measuring the ring widths, the transverse surfaces of all cores were smoothed to expose the rings. An Eclund Measuring Machine was used for measuring. The ring-width series for each tree was standardized using the standardization and indexing method explained by Schweingruber (1988). The values of indices varied around 1.0. Correlation coefficients (r) and Gleichläufigkeit (GL) values among the individual tree chronologies were calculated, and, after significant levels were achieved, the site master chronology was constructed by averaging the ten tree chronologies. Then, r and GL values between the site master chronology and the individual ring series, mean sensitivity, and first three autocorrelations were calculated.

The response function method (Fritts 1976) was used to investigate the microclimatic effects on the tree rings. Fritts and Wu (1986) state that this method is more effective than others. Climatic records, mean monthly temperature and total monthly precipitation from 1960 to 1994, were taken from Kandilli Observatory, located 2.7 km from the sampling site. The relationship between the master tree-ring index chronology and precipitation from January to September is graphed in Figure 3 because the most obvious parallel variations existed between them.

RESULTS AND DISCUSSION

The 109 year long site master chronology, from 1887 to 1995, is illustrated in Figure 1. Mean tree ring-width is 2.022 mm, and the mean index is 1.054. The correlation coefficients (r) and Gleichläufigkeit values (GL) between the site master chronology and the individual chronologies are significant at the 99.9 percent confidence level (Table 1).

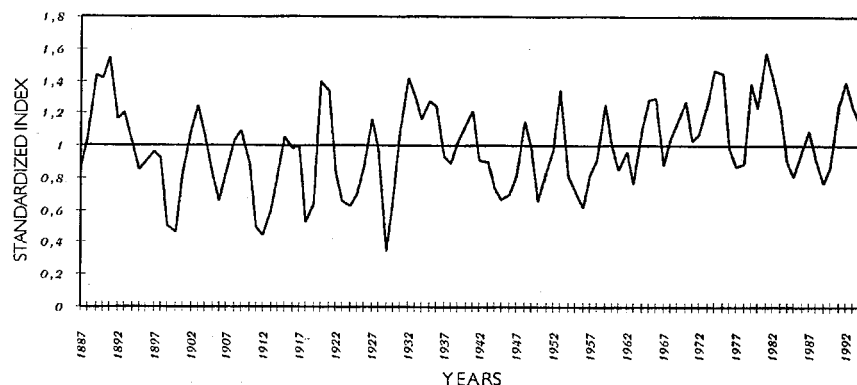


Figure 1. The site master chronology of *Pinus pinea* L.

Table 1. Gleichläufigkeit values (GL) and correlation coefficients (r) between the site master chronology and the individual chronologies. All values are significant at the 99.9% confidence level.

	Tree									
	1	2	3	4	5	6	7	8	9	10
GL	72.3	73.6	78.1	75.2	72.5	70.4	82.3	80.6	89.4	70.7
r	0.88	0.60	0.52	0.49	0.71	0.60	0.61	0.77	0.68	0.68

The response function (Figure 2) produced a high R^2 value of 0.655. Precipitation has a greater influence on the width of the tree ring than does temperature. January-February precipitation in winter, April-May precipitation in spring, and July-August precipitation in summer have significant positive influences, while June precipitation has a negative influence on ring width. Precipitation and temperature of the previous year and March precipitation of the current year do not significantly affect growth. Because the growing period begins in early March, March and April temperature have an important positive influence. Above-average temperature in May, June, and July has a negative influence. Because ring growth stops at the end of summer, relationships decrease after August. The low number of false and missing rings can probably be explained by the decrease of cambial activity in September, which also indicates that climatic conditions in autumn are not so important for tree-ring growth. To summarize, winter precipitation provides an important contribution to the water economy of the soil. Because of water deficiency in summer, precipitation in spring and summer, except June, are of great importance for tree growth.

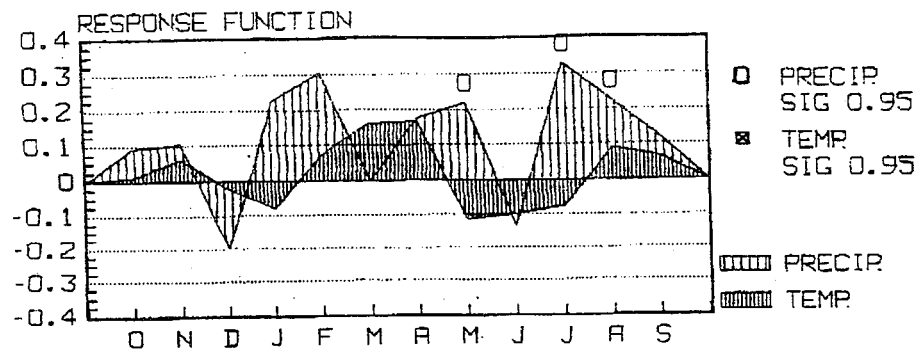


Figure 2. The response function; $R^2 = 0.655$.

Despite statements that sensitivity was low in pine species (Akkemik 1995; Richter, et al. 1991), Perez-Antelo and Fernandez-Cancio (1992) and Cherubini (1993) specified *Pinus pinea* L. as a dendroclimatically sensitive species. In this study, mean sensitivity was found to be high (0.291), and it was confirmed that this species was sensitive to climate in Istanbul. First order autocorrelation was calculated to be 0.57, second order 0.06, and third order 0.17. The first is significant, and the others nonsignificant.

The relationship between the site master chronology and total precipitation from January to September is illustrated in Figure 3. There is important parallel variation between the two graphs: during years in which precipitation was above average, wide rings formed; in years in which precipitation was below average, narrow rings formed. Biondi (1992) and Cherubini (1993) report characteristic narrow rings in the years 1945-1946. Narrow rings are found in the same years in Istanbul (Figure 1).

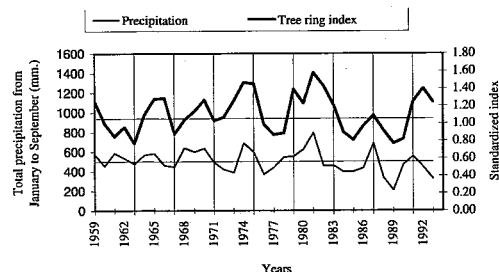


Figure 3. The site master chronology and total precipitation from January to September.

CONCLUSION

This study determined the dendroclimatic relationships of *Pinus pinea* L. in Istanbul. There is an important positive relationship between the widths of tree rings and monthly precipitation, except for March and June. Temperature is not an important influence, except in March and April. Because *Pinus pinea* L. is sensitive to climate, it can be used in dendroclimatology. Future research on samples from the Black Sea, Mediterranean, and especially Aegean regions of Turkey should produce additional useful results.

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