

A dendroecological study on *Pinus nigra* Arn. at different altitudes of northern slopes of Kazdaglari, Turkey

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Abstract: This study was carried out to investigate the relationship between tree ring widths of *Pinus nigra* in Kazdaglari having humid and very humid climatic conditions. Sixty two trees were cut from 24 sampled points from different altitudes in Kazdaglari to measure tree ring widths. To determine the responses to the climate, correlation coefficients between tree ring widths and climatic data were calculated during biological years from October of the previous year to September of the current year. In lower altitudes, where climate type is humid, spring and summer precipitation affect the growth of tree rings, but they are not statistically limiting factors. In higher altitudes, this effect is weaker. As a result, we can conclude that the negative effects of the drought are still not clear on the *Pinus nigra* trees under humid and very humid climatic conditions and at the northern slopes in submediterranean mountainous regions in Turkey.

Key words: *Pinus nigra*, Dendroecology, Drought risk, Kazdaglari

Introduction

The general distribution of *Pinus nigra* is especially high mountainous zones of the Mediterranean basin (Specht *et al.*, 1988). Its widest distribution in world is in Turkey with approximately 2.527.675 ha. Most parts of the natural distribution of this species in Turkey have a water deficiency during summer. According to the IPCC report (2001), drought risk is one of the most important issues in Europe, and the occurrence and frequency of hot days has increased during 20th century. This situation can be considered as an important issue affecting human health and natural ecosystems. Warming is an important issue to be considered in plantations of *Pinus nigra* alongwith site, altitude and slope selections.

Pinus nigra is resistant to climatic extremes in the areas from very humid sites in high mountainous regions to semi dry sites in central Anatolia (Saatcioglu, 1976; Mayer ve Aksoy, 1998). Due to being a sensitive species, it was used widely in dendroclimatological analysis (D'Arrigo ve Cullen, 2001). Beside some ecological conditions such as altitude, slope, soil and forestry treatments, global warming can also be used as indicators in site and species selections for plantation in the Mediterranean basin.

Being one of the most important tree species of forests and forestry activities in Turkey, *Pinus nigra* was selected as research material. The aim of the present study is (1) to investigate the relationships between climatic variables (total monthly precipitation and mean monthly temperature) and tree ring widths, and (2) to discuss the possible effects of drought on *Pinus nigra* trees growing on humid to very humid sites, where located in submediterranean region.

Materials and Methods

Study area is located at 39° 47' 00" - 39° 52' 30"N latitude and 27° 00' 00" - 27° 10' 00" E longitude. Climate type is humid to very humid. The study area was separated to 5 different altitudinal zones from 500 m to 1300 m as 400-600 m, 600-800 m, 800-1000 m, 1000-1200 m, and 1200-1400 m. In the first two zones, there is high water deficit in summer, and in last three zones, there is moderate water deficit in summer. The main rock is granite (Kantarci, 1996). The canopy of stands, from which the sample trees were selected, were equal to or more than 0.8, soil was deep.

Sixty two stem discs from 24 sampling points on the North slope and 5 different altitudinal zones of Gürgendag (Kazdaglari) were taken. Even aged trees were selected in the zones. Stem discs were polished by using a sand paper. Tree ring widths were measured nearest to the 0.01 mm on two directions of the stem discs. First, individual chronologies for each sample was constructed and then, 5 site chronologies were constructed for each altitudinal zones. Between trees, correlation coefficients (r) were calculated to find the agreement, and then t values were calculated to test the level of significance (Fritts, 1976; Schweingruber, 1988).

For each altitudinal zone, correlation coefficients between tree ring widths and monthly mean temperature and monthly total precipitation were calculated. In this calculation, biological year, which is from October of the previous year to September of the current year (Fritts, 1976; Lebourgeois, 2000), was used.

Result and Discussion

Correlation coefficients between trees decrease from lower sites to the upper ones (Table 1). This is the result that

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trees in lower altitudes response to the environmental conditions more homogeneously. Because limiting factors, which are especially dry conditions, decrease towards upper elevations, the correlations between trees also decrease.

The response of tree ring growths to precipitation and temperature are generally similar in five different altitudinal zones (Fig.1). However, the trees in the zones I, II and III, have a positive response to precipitation in May to August. In the zones IV and V, this response is lower. In general inverse relationship can be seen between tree ring growth and temperature in the same months. None of the coefficients are significant at the 0.95 confidence level. These results show that in first three zones, precipitation has an important positive effect on treering growth during growing season, but they are not statistically significant. However, dry years cause significantly narrow ring formation. Correlation coefficients are higher in the zone III. The cause of

Table - 1: Correlation coefficients between trees within the five groups of altitudes on the northern slope and their means; (*) (**) and (***) indicate 95%, 99% and 99.9% confidence levels, respectively

	Mean correlation					
V	Ö-4	Ö-32	Ö-33	Ö-38		
	Ö-4	1				
	Ö-32	0,58***	1			
	Ö-33	0,20	0,36	1		
	Ö-38	0,33	0,27	0,30	1	0,34
IV	Ö-11	Ö-18	Ö-34	Ö-36	Ö-39	
	Ö-11	1				
	Ö-18	0,81***	1			
	Ö-34	0,39***	0,73***	1		
	Ö-36	0,89***	0,57***	-0,02	1	
	Ö-39	0,38***	0,93***	0,16	0,26	1
						0,51***
III	Ö-6	Ö-9	Ö-10			
	Ö-6	1				
	Ö-9	0,76***	1			
	Ö-10	0,43***	0,94***	1		0,71***
II	Ö-5	Ö-13	Ö-16	Ö-20	Ö-31	
	Ö-5	1				
	Ö-13	0,90***	1			
	Ö-16	0,25*	0,55***	1		
	Ö-20	0,82***	0,87***	0,81***	1	
	Ö-31	0,54***	0,52***	0,74***	0,66***	1
						0,67***
I	Ö-1	Ö-21	Ö-25	Ö-26	Ö-27	Ö-28
	Ö-1	1				
	Ö-21	0,32	1			
	Ö-25	0,76***	0,77***	1		
	Ö-26	0,31**	0,86***	0,86***	1	
	Ö-27	0,62***	0,88***	0,86***	0,90***	1
	Ö-28	0,79***	0,85***	0,95***	0,88***	0,95***
	Ö-29	0,84***	0,64***	0,88***	0,71***	0,83***
						0,93***
						0,78***

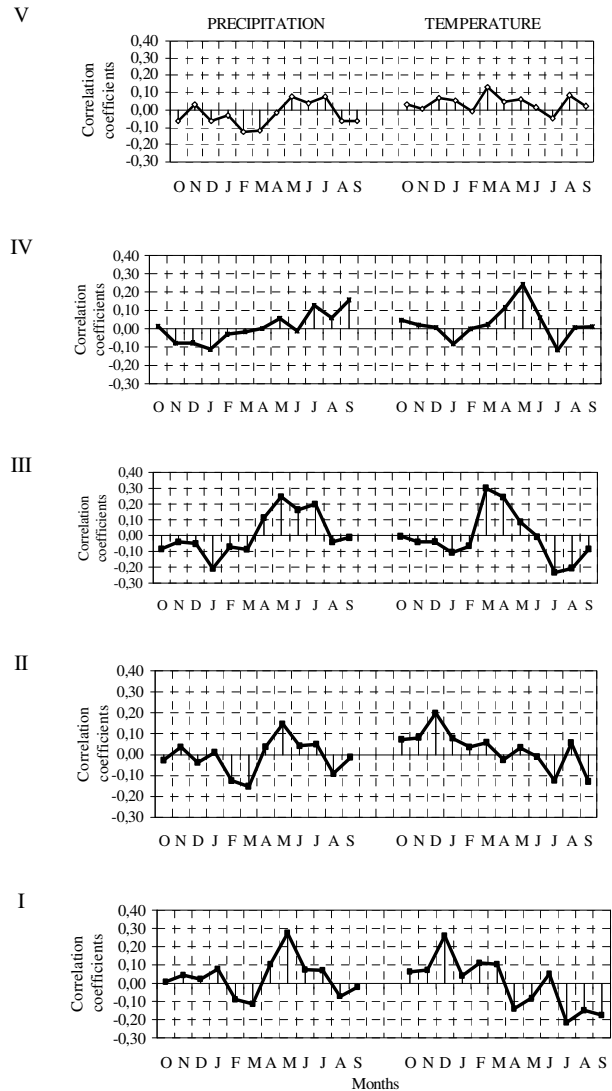


Fig. 1: Correlation coefficients between treering widths from different altitudes on northern slope and monthly precipitation and temperatures from October of the previous year to September of current year

this can be which of this zone is on the ridge, water storage in the soil is lower, and radiation is higher. These conditions can increase the amount of evapotranspiration, and then cause narrow ring formation.

The effect of summer temperature is very low and not significant. This has an important negative effect in the lowest zone (I) and in the zone III. The results showed that temperature is not a limiting factor for trees on deep soils and high altitudes on north slopes of sub Mediterranean region. The effect of precipitation is more homogeneous during growing season in lower altitudes (zone I, II and III). This outcome can also be seen between tree correlations (Table 1). D'arrigo and Cullen (2001), Touchan *et al.* (2003), and Akkemik and Aras (2005) stated that



Black pine trees in lower altitudes in Mediterranean region in Turkey have significantly positive response to precipitation.

In spite of lower three zones a humid climate and upper two in very humid, the study area is under the sub Mediterranean climate region in general. In this region, precipitation in May to June, which is the fast growing and fast cambial activity season around Turkey (Akkemik, 2000; Touchan *et al.*, 2003; Akkemik and Aras, 2005), has an important positive effect on tree ring widths, but not significant in humid and very humid sites. However, the amount of this effect is higher and statistically significant in dry sites around Turkey (Touchan *et al.*, 2003; Akkemik and Aras, 2005). In contrast, temperature has a considerable negative effect on tree ring width in the same time, but it is not statistically significant in general. The results showed that *Pinus nigra* trees, growing on deep soils and under humid climate conditions such as here, may not be affected by normal climatic conditions, except extreme dry years.

Global warming is one of the most important issues of the world in near future. Bindi and Olesen (2003), Cherubini *et al.* (2003) and Körner (2003) pointed out that drought risk is the most important issue for Mediterranean basin and during last decades, the frequency of warm air waves have increased. Because our study area is under the humid and very humid conditions in sub Mediterranean regions, the effect of global warming is not clear and probably this issue will not be an important effect on the trees around humid regions in near future. However, because felling age in *Pinus nigra* is more than 80 years in Turkey, forest planners should consider species and site selections in plantations.

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