

## Relations between Growth and Some Ecological Properties of Fir Stands in Gümüşhane-Karanlıkdere

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### Abstract

Site index affects tree growth in various ways. Thus, while it can be optimal for one it also can be bad for the other. Relations between growth and some ecological properties of Norman fir (*Abies nordmanniana* subsp. *nordmanniana*) were studied. Location of these fir stands is Gümüşhane-Karanlıkdere.

The research area comprises 1122.0 ha and is located in the eastern Black Sea region, about 40 km away from Gümüşhane Province, Turkey. Meanwhile, this area is located in the upper land of the Harşit River which carries effects of the sea to the land but the climate of this area is moist, cold, with high water shortage during vegetation period so similar to the continental climate.

In this study, 44 sample areas were established within fir stand locations. In all areas soil samples were taken from their soil profiles. Soil size particle (clay percent, silt percent, sand percent) analyses, organic matter percent, pH, electrical conductivity (EC), available water capacity (AWC) analyses were carried out in the collected soil samples.

The study results have demonstrated a relation between fir growth and some ecological properties of their sites.

**Key Words:** Norman fir, efficiency, ecological properties

### Introduction

Plants are able to live and are constantly influenced by the physiographic, edaphic, climatic and biotic conditions in the forest areas. A balanced and dynamic relation between these conditions (ecological environment) is known as (habitat) site index. In other words, "forest habitat" has complex factors supporting the growth of forest plants and constantly influencing them (Kantarci, 1980).

Determination of habitat conditions in the natural range of forest trees is important for forest management and scientific research. To understand the habitat of any tree species, a silvicultural intervention is performed in stands belonging to this tree species allowing for the selection of accurate tree species to reforestation areas.

For a successful management plan one should start with the most effective growing areas, accurately choose the tree species more economically valuable than the others and deeply understand the habitat.

In this study, relations between growth and some ecological properties of Norman fir (*Abies nordmanniana* subsp. *nordmanniana*) which is naturally spreading at the boundary of Kocadal village belonging to Torul,

Gümüşhane were investigated in Gümüşhane-Karanlıkdere.

Norman fir (*Abies nordmanniana* subsp. *nordmanniana*) naturally spreads to the Eastern Black Sea region in Turkey and western Caucasus region adjacent to the Eastern Black Sea. The highest quality Norman fir stands are located in Turkey between 1,500 and 2,000 m asl (Saatçioğlu, 1976). This distribution area is part of the moisture-rich eastern Black Sea mountains edge, under the influence of Black Sea. Some of this range located at the back of mountain zones has a continental climate (Demirci, 2001).

Norman fir has a very decorative appearance, with intense branches, long and coiled needles, therefore is extremely favorable for parks and gardens. For this reason it is used for Christmas trees (Karaşahin et al., 2002).

### Research Area

The study area extends between 39°11'14" and 39°14'06" E longitudes and between 40°17'39" and 40°20'28" N latitudes. This area is located in Kocadal village, Torul district, Gümüşhane province.

Kocadal village is 40 km away from Gümüşhane. The average elevation is around 1,900 m and it has a high mountainous terrain feature. In general, the northern aspect

is dominant in the study area (Bakkaloğlu, 2003).



Figure 1. Geographical location of research area



Figure 2. Stands of fir and Scots pine in the study area

Study area extends to the backward of the eastern Black Sea Region. In this region, the mountains are parallel to the Black Sea shore and there is no big river basin where the Black Sea climate type can effect throughout.

However, the effect of the sea reaches the research area along the creek Harşit. But, this humidity is not enough and a significant dry period affects the vegetation in the research area (Torul district) (Öztan, 1974; Kantarcı,

1995). The research area is located between 1,720 and 2,150 m asl. The water balance values according to the Thornthwaite method

are shown below (DMİGM 2002; Erinç, 1996; Thornthwaite and Hare, 1955, Kantarcı, 1972).

Table 1. The water balance values for 1,900 m elevation in the research area according to the Thornthwaite method

Climate index	Months												Vegetation		Annual
	Vegetation												In	Out	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
Temperature °C	-5.3	-4.2	-1.1	6.1	10.3	13.7	16.6	16.5	13.1	7.8	1.6	-2.9			6.0
PET	0.0	0.0	0.0	37.5	68.7	90.8	109.5	102.2	72.0	40.9	7.9	0.0	443.2	86.2	529.4
Precipitation (mm)	58.0	55.8	64.9	82.6	91.9	72.4	37.1	38.0	45.6	68.1	64.3	68.6	285.2	462.4	747.6
Storage Diff.	-	-	-	-	-	-18.4	-72.4	-9.2	-	27.3	56.4	16.3			
Storage (AWC)	100.0	100.0	100.0	100.0	100.0	81.6	9.2	-	-	27.3	83.7	100.0			100.0
Actual ET	-	-	-	37.5	68.7	90.8	109.5	47.2	45.6	40.9	7.9	-	361.9	86.2	448.1
Water Deficiency	-	-	-	-	-	-	-	54.9	26.3	-	-	-	81.3	0.0	81.3
Surplus water	58.0	55.8	64.9	45.1	23.2	-	-	-	-	-	-	52.3	23.2	276.2	299.4
Runoff	42.2	49.0	57.0	51.0	37.1	18.6	9.3	4.6	2.3	1.2	0.6	26.4	0.0	299.4	299.4

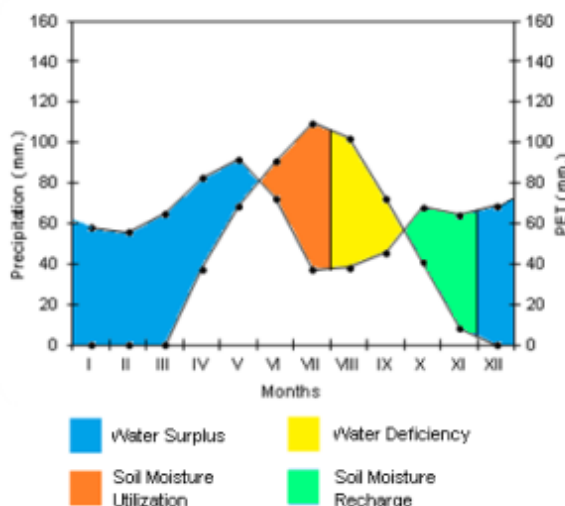


Figure 3. The water balance in the research area

The research area has the symbol B2C'2rb'2 meaning "humidity, low temperature (micro thermal), without or very little water flow, close to the continental climate.

The research area is the southern border of the Pontides Tectonic Union. The parent material is Paleozoic granite (Çınar, 1985).

Granite makes up usually sandy loam and loamy sand soils. Soil reaction is acidic, water-holding capacity is poor, permeability is very good. In terms of forestry, this bedrock type is unsuitable in dry climates whereas suitable soils are formed in humid climates (İzbirak, 1969).



Figure 4. Soil profile under the fir stand

## Material and Method

### Material

The research material is composed of topographic maps (Scale 1:25.000), climate data, geological maps (scale 1:25.000), various data such as aspect, elevation, slope, etc. collected from temporarily systematic sample plots; 141 soil samples were taken from the research site.

### Method

This study was carried out in three stages including fieldwork, laboratory work, and evaluation process.

#### *Determination of Specific Position Factors*

Some data such as elevation, slope, aspect, relief, and specific information for the neighboring environment were collected for Specific Position Factors.

#### *Determination of Soil Properties*

Soil profiles were dug up and their layers were determined for each sample plot (Irmak, 1970; Kantarcı, 2000). Soil samples were taken after determining the thickness of each layer. In addition, for each soil profile the absolute, physiological, and excavation depth were assessed (Çepel, 1984-1985).

#### *Laboratory Analysis*

The soil samples were prepared for analysis after air-drying, grounding inside the

mortar and sifting through 2 mm sieve (Gülçür, 1974; Karaöz, 1989a). The soil analyses were conducted on the soils with particle diameter < 2 mm using standard methods. The determination of particle size distribution (i.e. sand, silt, and clay) of the soils was carried out by using the Bouyoucos hydrometer method; soil acidity (pH) was analyzed according to the glass electrode method in pure water and the analysis of soil organic matter (SOM) by using Walkley-Black wet burning (Gülçür, 1974; Arp, 1999; Karaöz, 1989b). The amount of available water capacity was also determined (Karaöz, 1989a; Kantarcı, 2000).

#### *Determination of Present Productivity*

As known, the average height of dominant trees in a stand is one of the best criteria to define the present productivity of even-aged stands. Therefore, the dominant height at a standard age is used as a criterion for the determination of present productivity classes (site index classes) in a research area (Günlü et al., 2006). In our country, the determination of different classes of old dominant trees was made by Saracoglu (1988) according to the Lloyd-Haffley (1977) method.



Figure 5. Correlation age-dominant height in fir stands

#### *Statistical Analysis*

First of all, partial correlation analysis was used to investigate the relationships between site productivity and site factors depending on ecological variables. Finding a good relationship, after partial correlation

analysis, regression analysis was performed for the site traits. Subsequently new regression equations were established (SPSS, 15.0).

## Results and Discussion

### Correlation analysis

Result of partial correlation analysis between the site traits (e.g., slope, elevation, sand, silt, clay, pH, organic matter, field capacity, wilting point, available water capacity) of Norman fir and site index: the ecological variables elevation, sand, silt, clay, pH, field capacity and AWC were significantly correlated with the SI of Norman fir.

The ecological variables elevation ( $p < 0.001$ ,  $r = 0.494$ ), % silt ratio ( $p < 0.001$ ,  $r = 0.327$ ), % field capacity ( $p < 0.001$ ,  $r = 0.221$ ) and AWC % ( $p < 0.001$ ,  $r = 0.257$ ) were positively correlated with the site index of Norman fir in Karanlıkdere. In contrast, the % sand ratio ( $p < 0.001$ ,  $r = -0.228$ ) and pH ( $p < 0.001$ ,  $r = -0.353$ ) were negatively correlated with SI. In ecological terms means that the increase of elevation, silt ratio, field capacity and AWC directly increases the productivity of Norman fir.

Norman fir in Karanlıkdere was distributed between 1,720 and 2,150 m asl. The slope of sample plots changes between 35 and 75%. Soil properties such as sand ratio 76.6–97.4%, clay ratio 1.0–12.9%, silt ratio 0.2–10.6%, soil reaction (pH) 5.36–7.17, organic matter 0.22–9.75%, field capacity 6.6–32.2%, wilting point 3.4 – 23.3%, and AWC 0.3–12.9% were found.

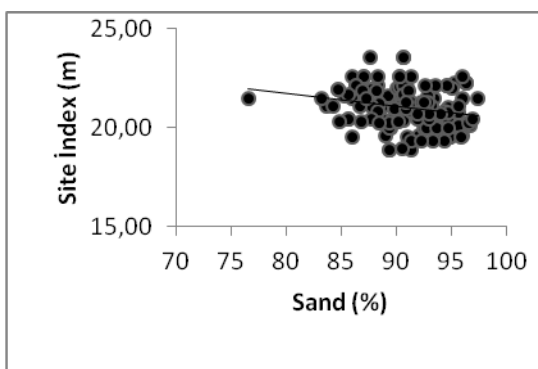


Figure 6. Relationship between SI and altitude

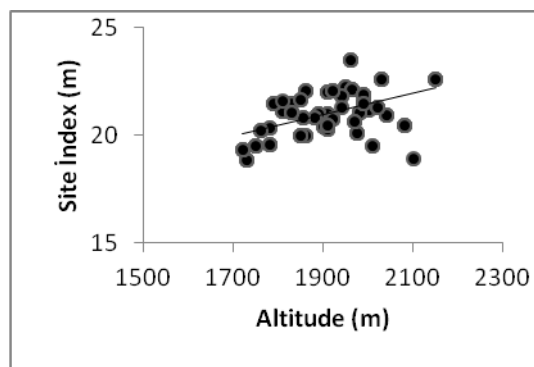


Figure 7. Relationship between SI and sand

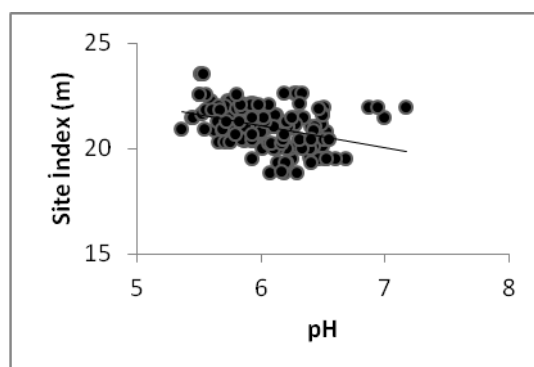


Figure 8. Relationship between SI and toz

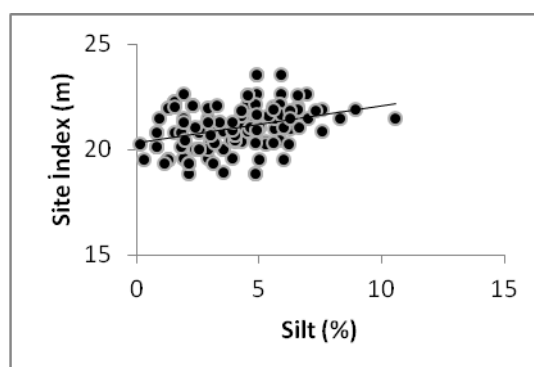


Figure 9. Relationship between SI and pH

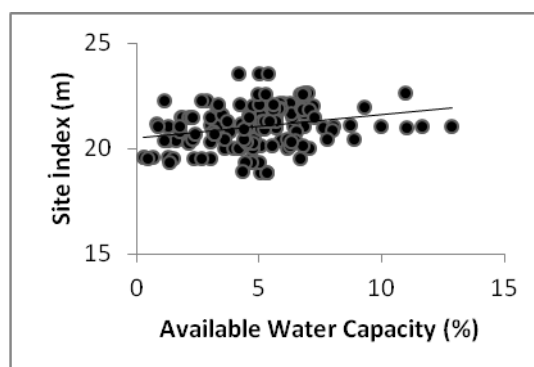


Figure 10. Relationship between SI and FC

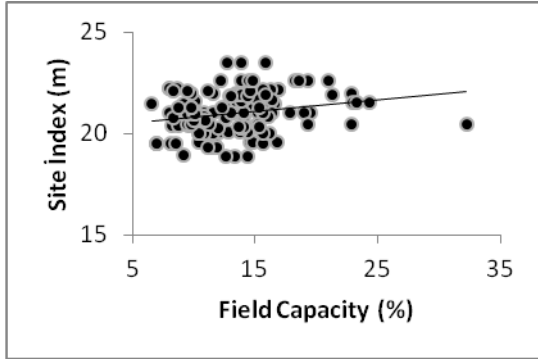


Figure 11. Relationship between SI and AWC

### Regression Analysis

According to the results of the partial correlation analysis, SI is related to the properties of site factors. Using multiple regression models the effect of site factors on SI was determined.

As a result of regression analysis, these equations were obtained:

$$1. SI = 11.643 + 0.005 \times \text{altitude (m)} \quad (R^2 = 0.244)$$

$$2. SI = 17.109 + 0.004 \times \text{altitude (m)} - 0.704 \times \text{pH} \quad (R^2 = 0.298)$$

### Conclusion

This study was carried out in Norman fir (*Abies nordmanniana* subsp. *nordmanniana*) forests located in the outskirts of Torul district, Gümüşhane Province which is located in the back of eastern Black Sea region. The study was conducted locally therefore the results are valid for Norman fir trees of Karanlıkdere area. It is necessary to investigate the relationships between site factors and site index of Norman fir that is widely distributed in different sites of eastern Black Sea region.

Thus, based on local studies it will be easy to understand how different conditions can affect the productivity of fir stands in the above region.

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