

Effects Of South And North Aspects On Growth In 4- Years Reproductions Of Pinus Brutia

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Abstract – This study was carried out to determine aspectual (south and north) effect on growth by height and root-collar diameter in 4-years reproductions of Brutian pine (*Pinus brutia* Ten.) to contribute natural regeneration and other forestry practices in the species. South aspect (105.5 cm for height and 25.7 mm for root-collar diameter) showed higher growth performances for the characteristics than north aspect (69.7 cm and 13.8 mm). Root-collar diameter was more heterogeneous than height based on coefficient of variations for at both aspects.

Results of analysis of variance showed significant differences ($p<0.01$) between aspects for the characteristics. There were positive and significant ($p<0.05$) correlations between height and root-collar diameter at aspects.

Keywords – Height, Regeneration, Sampling, Survival, Variance.

I. INTRODUCTION

Brutian pine (*Pinus brutia* Ten.) is one of the most important tree species by 5.3 million ha natural distribution in Turkish forestry [1] and the “National Tree Breeding and Seed Production Programme” [2], and for forestry practices. However, many factors (i.e., aspect, slope, altitude and soil characteristics) and their interactions could be effective biologically or environmentally in these practices, and biotic and a-biotic conditions. While some studies were carried out on effect of these factors in different forest tree species [e.g., 3-8], new studies were suggested by [6] and [7] carried out on two and four years regeneration areas of Brutian pine at different ecological conditions.

New studies were needed to give detail conclusions based on early studies. In the present study, effect of north and south aspects on height and root-collar diameter in 4 year natural regeneration areas of Brutian pine was examined to contribute forestry practices in the species.

II. MATERIAL AND METHODS

2.1. Sampled areas

The studied areas were sampled aspectual from natural regeneration areas regenerated four years ago of Brutian pine. The areas, sampled from south and north aspects, were close each other which were 250 m² (25x10 m) to minimize effect of other environmental and biological factors based on purpose of the study, from natural distribution of the species at southern part of Turkey (Table 1, Figure 1).

Table 1. Location of sampled areas

Aspect	Latitude (N)	Longitude (E)	Altitude (m)
South	37°37'23"	30°46'21"	870
North	37°37'23"	30°46'20"	856



Figure 1. Views from the south (left side) and north (right side) aspect areas.

The sampled areas were regenerated by shelter wood method of cutting in 2018. Slope of the areas were between 25% and 35%. Soil characteristic was clay in the areas.

2.2. Data collection and analysis

Height (H) and root-collar diameter (RCD) of reproductions also called sapling were measured in 85 individuals from south and 146 from north aspects at end of growth period of 2022.

The sampled areas/aspects were compared by following linear model of analysis of variance at SPSS package [9].

$$Y_{ij} = \mu + P_j + e_{ij}$$

Where Y_{ij} is the observation from the j^{th} reproduction of the i^{th} area, μ is overall mean, P_i is the random effect of the i^{th} area, and e_{ij} is random error.

Phenotypic Pearson' correlation (r_p) between height and diameter were estimated by [10]:

$$r_p = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

Where $\sum xy$ is the sum of the factors of the characters x and y, $\sum x^2$ and $\sum y^2$ are phenotypic variances the characters x and y, respectively.

III. RESULTS AND DISCUSSION

3.1. Height and root-collar diameter

Growth performances of height and root-collar diameter were higher in south (105.5 cm & 25.7 mm) aspect than north (69.7 cm & 13.8 mm) aspect for both characteristics (Table 2, Figure 2). Averages of growth performances were reported 21.52 cm for height and 22.46 mm root-collar diameter at north aspect, and 23.42 cm and 22.45 mm at south aspect, respectively by [6]

for 2 years reproductions of the species. It could be said that increment of height (23.42 cm and 105.5 cm) was higher at south aspect than north from 2 years to 4 years, opposite to root-collar diameter. They were found 106.3 cm for height and 24.2 mm for root-collar diameter for different slope groups in 4 years reproductions of Brutian pine [7]. Large differences were also found among individuals within aspect for the characteristics. For instance height ranged from 31.0 cm to 179.0 cm in south aspect (Table 2). It could be emphasized importance of mother trees. It was also reported in Taurus cedar (*Cedrus libani* A. Rich) by [11]. The results showed importance of local factors and mother trees, and also local forestry practices.

However, north aspect (5840/ha) had higher individuals than south aspect (3400/ha) (Table 2). They were 5400/ha at 4 years regeneration areas [7] and 6500/ha at 2 years regeneration areas [6].

Table 2. Average, range and coefficient of variations (CV%) for the height (H) and root- collar diameter (RCD) at aspects

	South (85)*		North (146)	
	H (cm)	RCD (mm)	H (cm)	RCD (mm)
Average	105.5	25.7	69.7	13.8
Range	31.0 - 179.0	5.9 - 55.3	35.0 - 141.0	5.7 – 28.3
CV%	32.7	42.8	26.3	34.1

*; Number of measured individuals in parenthesis.

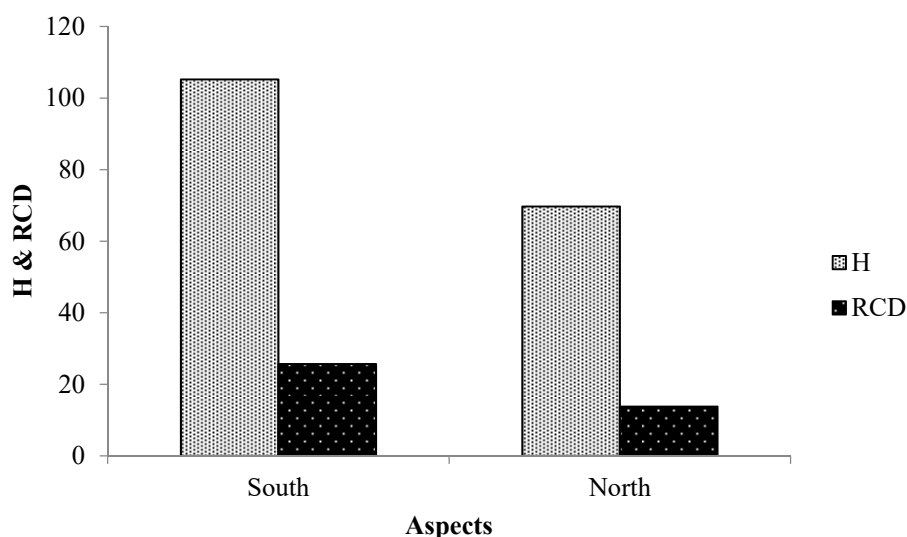


Figure 2. Averages of the characteristics at aspects

Coefficient of variations was higher in root-collar diameter than height in both aspects (Table 2). There were significant differences ($p < 0.01$) for the characteristics between aspects based on results of analysis of variance (Table 3). Similar results were also reported for aspects [6] and for slopes [7] in years regeneration areas of Brutian pine. It was reported that altitude, aspect, and location on the slope were effective on the generation success in Brutian pine by [12].

Table 3. Results analysis of variance for the height (H) and root-collar diameter (RCD) according to aspects

Character s	Source of variation	Sum of squares	Degrees of freedom	Mean of squares	F value	P
H	Between groups	68850.994	1	68850.994	106.268	.000

	Within group	148369.396	229	647.901		
	Total	217220.390	230			
RCD	Between groups	7611.519	1	7611.519	129.294	.000
	Within group	13481.148	229	58.870		
	Total	21092.667	230			

3.2. Correlations between height and root-collar diameter

Positive and significant ($p < 0.05$) relations between height and root-collar diameter were found by Pearson's correlation analysis in south ($r_p = 0.913$), north ($r_p = 0.656$), and both aspects ($r_p = 0.891$). Similar relations were also found in natural regenerations [6-7], and seedlings [e.g., 13-14] in Brutian pine. The results were also supported by regression analysis (Figure 3).

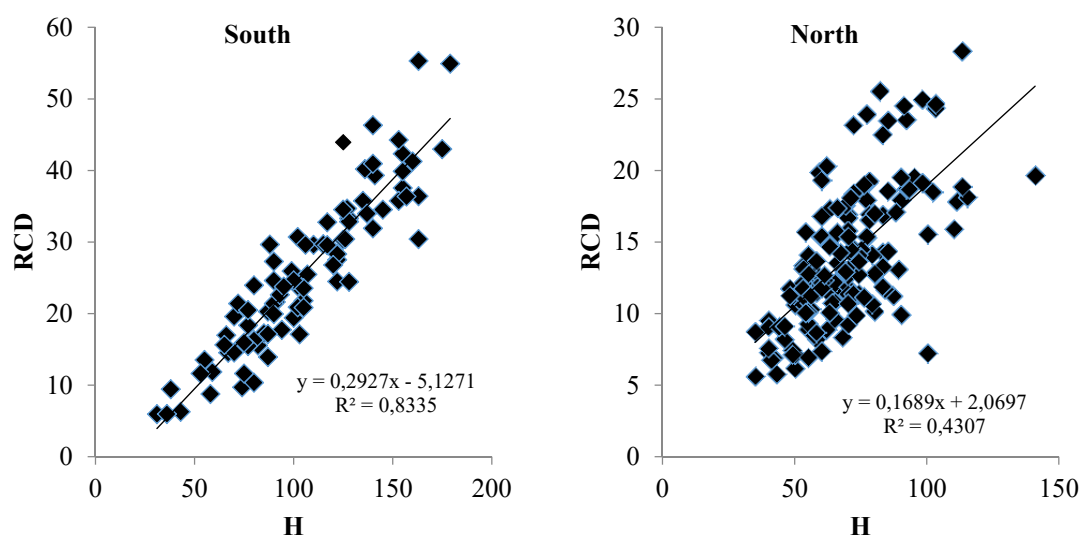


Figure 3. Results of regression analysis

According to results of regression analysis root-collar diameter could be formulated by $RCD = 0.2927H - 5.1271$ ($R^2 = 0.8335$) at south aspect, and $RCD = 0.1689H + 2.0697$ ($R^2 = 0.4307$) at north aspect (Figure 3).

IV. CONCLUSIONS

It could be suggested that aspect could be taken into consideration especially global warming in forestry practices of the species based on results of the study and early studies in the species. Results of regression analysis should be used for future estimations in the species. New aspectual studies could be carried out in different ages of the species.

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