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EFFECT OF ASPECT ON GROWTH VARIATION IN MOTHER TREES OF TAURUS CEDAR (*CEDRUS LIBANI*)

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Abstract: Aspectual effect as an environmental factor on growth variation by tree height, diameter at base, diameter at breast height and crown diameter of mother tree (also called seed tree) were investigated in a seed collection population of Taurus cedar (*Cedrus libani* A. Rich) to contribute selection and establishment seed sources of the species in this study. Growth performances varied for the aspects and characteristics. Eastern aspect had generally the highest growth performances except of tree height of straight aspect. However, there was significant differences (*p<0.01*) only for tree height among aspects. The growth characteristics were more homogenous in straight aspect than the others based on coefficient of variations.

Generally, statistically significant (*p<0.05*) and positive correlations were found among the characteristics.

The results emphasized importance of aspect and characteristics for selection criterions and other forestry practices.

Keywords: Diameter, environment, height, seed, selection.

Introduction

Cedrus libani A. Rich (Taurus cedar or also called Lebanon cedar) has the largest natural distribution mainly on the Taurus Mountains in southern Turkey by 405 424 ha (Anonymous, 2022), and small populations are remained in Syria and Lebanon in whole the world (Boydak, 2003). It is also classified as one of the economically important species for Turkish forestry and the "National Tree Breeding and Seed Production Programme" (Koski and Antola, 1993) because of its valuable wood product and large natural distribution in Turkish forestry.

32.84% of the species and 41.74% of Turkish forest area which is 23.1 million ha (Anonymous, 2022) are degraded, while it is reported that the suitable plantation area for the species is 600.000 ha by Boydak (2003). Annual seed production is about 139 tones based on forestry inventory between 2012 and 2018 from the seed stands of Taurus cedar (Anonymous, 2019). Seed collection areas selected phenotypic or established artificial have important roles in conversion of degraded forest to productive forest. It is known that up to 20% additional gain can be obtained by a better selection of seed sources from natural

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forest (Urgenc, 1982) or more than that (Kang and Bilir, 2021). The species has 22 seed stands at 3437.8 ha and 9 seed orchards at 60.55 ha (Anonymous, 2021). Many biological (i.e., volume, height, diameter, age, stem straight, pure stand) and environmental (i.e., altitude, size, location, edaphic and climatic characteristics) criterions are used in selection of seed collection areas from natural forests (Zobel and Talbert, 1984). Aspect which is easy and cheap could be also considered as an environmental criterion in the selection. However, while many studies were carried out on seed collection areas (i.e., Yahyaoglu *et al*., 2001; Ulusan and Bilir, 2008; Bilir and Kang, 2014; Yazici and Bilir, 2017; Bilir and Kang, 2021) of Taurus cedar, aspectual effect on growth variation of seed collection areas have not been studied in the species or other forest tree species, yet.

Effect of aspect on growth variation is examined to contribute selection and establishment of seed sources, and to discuss as a possible selection criterion of aspect which is easy and cheap environmental selection factor in Taurus cedar, in this study.

Material and Methods

Sampled areas. The seed trees were sampled as aspectual from a seed collection population of the species, located (37°53' N latitude, 31°18' E longitude, 1630 m asl.) at southern part of Turkey (Figure 1). 20 trees, chosen randomly according to height, diameter, stem straight (Zobel and Talbert, 1984) were selected from north (**N**, 115 years, 1620 m asl.), south (**SO**,

140 years, 1636 m asl.), east (**E**, 141 years, 1626 m asl.), west (**W**, 120 years, 1626 m asl.), and straight (**ST**, 120 years, 1635 m asl.) aspects.

Figure 1. Sampled populations and mother trees

Data collection. Tree height (**H**), diameter at base (**D_0**), diameter at breast height (**DBH**), and crown diameter (**CD**) of sampled trees were measured in each aspect at end of 2021.

Data analysis. Aspects were compared by one-way Analysis of Variance (ANOVA) at SPSS package (SPSS, 2011). Phenotypic Pearson' correlation (r_p) between tree height and diameter at breast height were estimated by Rohlf and Sokal (1995).

Results and Discussion

Characteristics. Averages and coefficient of variations of characteristics were given in Table 1 for the aspects. Growth performances of the aspects changed for the characteristics. However, eastern aspect had generally the highest growth performances except of tree height of straight aspect, while they were the lowest in western aspect (Table 1, Figure 2). Variations of the growth characteristics varied for the aspects and characteristics. They were more homogenous in straight aspect than the others based on coefficient of variations, while it was the highest for tree height (25.94%) and diameter at breast height (36.33%) in western aspect, for diameter at base (37.54%) in eastern aspect, and for crown diameter (37.54%) in northern aspect (Table 1, Figure 2). The results emphasized importance of aspect and characteristics for selection criterions and other forestry practices. However, there could be many biological and environmental factors (Zobel and Talbert, 1984; Yazici, 2018) could be effective on the growth performance such as population (Yahyaoglu *et al.*, 2001). There were also large differences among individuals within aspects. For instance, tree height varied between 12.5 m and 25.0 m in northern aspect, and between 20.0 m and 26.0 m in straight aspect. It showed importance genetic structure and location of the seed tree within aspect.

Table 1. Averages (x) and coefficient of variations (CV%) for the aspects.

	Aspects									
Characteristics	**N**		**SO**		**E**		**W**		**ST**	
	x	CV	x	CV	x	CV	x	CV	x	CV
H (m)*	19.75^{ab}	18.63	21.95^{bc}	13.03	20.55^{ab}	18.64	18.58^{a}	25.94	22.96^{c}	7.62
D_0 (cm)	69.80	34.24	81.45	28.53	82.25	37.54	66.60	32.57	77.55	12.38
DBH (cm)	61.40	36.12	68.85	28.63	69.10	33.15	57.70	36.33	65.35	17.37
CD (m)	8.26	35.47	9.25	29.62	9.39	32.87	8.02	28.93	8.26	19.25

*; The same letters showed not significantly different at $p>0.05$.

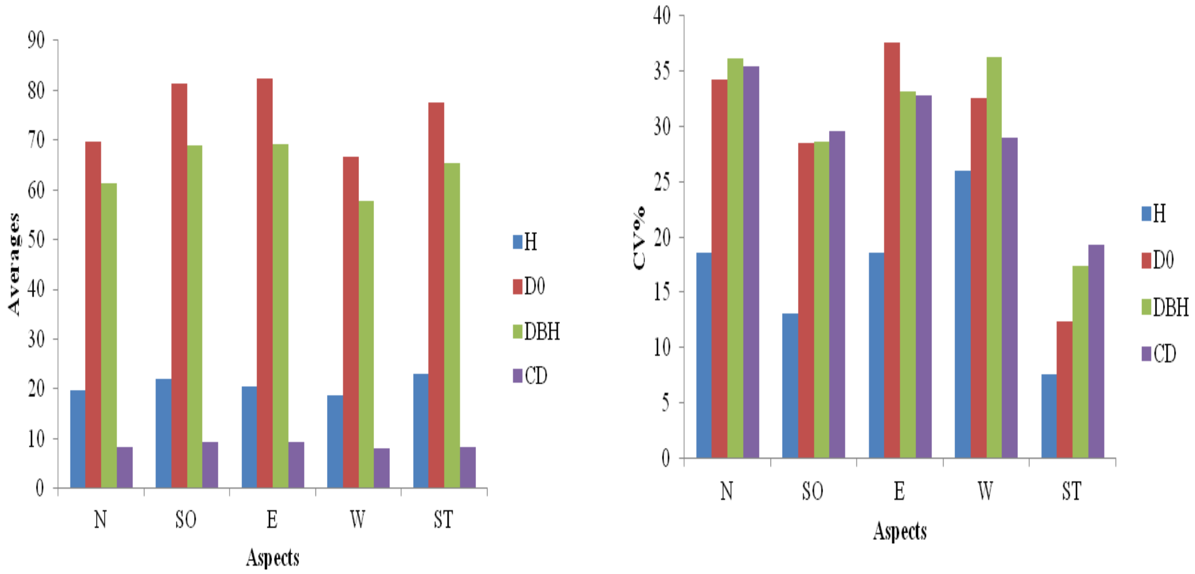

Figure 2. Averages and coefficient of variations (CV%) of the characteristics for the aspects.

Results of analysis of variance showed significant differences (*p<0.01*) only for tree height among aspects (Table 2). Aspects had three homogenous groups for tree height based on Duncan's multiple range test (Table 1). Similar results were also reported among provenances (Yahyaoglu *et al.*, 2001) and plantation populations (Bilir *et al.*, 2018) of the species.

Table 2. Results analysis of variance for the characteristics according to aspects

Characters	Source of variation	Sum of squares	Degrees of freedom	Mean of squares	F value	*P*
H	Between groups	243.215	4	60.804	4.848	.001
	Within group	1191.525	95	12.542		
	Total	1434.740	99			
D_0	Between groups	3839.660	4	959.915	1.826	.130
	Within group	49933.650	95	525.617		
	Total	53773.310	99			
DBH	Between groups	1933.060	4	483.265	1.224	.306
	Within group	37499.900	95	394.736		
	Total	39432.960	99			
CD	Between groups	32.154	4	8.039	1.197	.317
	Within group	637.916	95	6.715		
	Total	670.070	99			

Correlations. Relations among the characteristics changed for the aspects, while there were positive and significant (*p<0.05*) correlations among the characteristics in total aspects (Table 3). Similar results were also reported in plantations of the species (Bilir, 2004; Bilir *et al.*, 2018). The results could be used for selection and other forestry purposes such as tending in the species.

Table 3. Averages (x) and coefficient of variations (CV%) were given for the aspects.

Aspects	Characteristics (r)*	H	D_0	DBH
N		.506*	-	
SO		.364^{NS}	-	
E	D_0	.490*	-	
W		.369^{NS}	-	
ST		-.038^{NS}	-	
Total		.427**	-	
N		.413	.975**	-
SO		.476*	.936**	-
E	DBH	.466*	.965**	-
W		.338^{NS}	.974**	-
ST		-.029^{NS}	.833**	-
Total		.405**	951**	-
N		.271^{NS}	.871**	.887**
SO		.266^{NS}	.849**	.854**
E	CD	.121^{NS}	.786**	.796**
W		.422^{NS}	.833**	.851**
ST		-.042^{NS}	.684**	.679**
Total		.244*	.822**	.834**

******; Correlation was significant at the *0.01* level, *****; Correlation was significant at the *0.05* level, ^{NS}; Correlation was not significant ($p>0.05$).

Conclusions

criterion in the selection of seed collection areas. However, there could be effective many biological and environmental factors on growth performance and its variation. New studies should be carried out by different environmental factor and growth characteristics in the species.

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