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Investigation of Plantations in Isparta-Yalvac District of Turkey

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Abstract: ***Afforestation which one of the most important forestry practices by Anatolian black pine (Pinusnigra) and Taurus cedar (Cedruslibani) in Isparta-Yalvac district of Turkey were investigated based on height, diameter and survival.***
Averages of height and diameter were 161.3 cm and 38.7 mm for Anatolian black pine, and 226.6 cm and 74.3 mm Taurus cedar based on collected data from 95 Taurus cedar individuals and 134 Anatolian black pine individuals.
There were positive and significant (p≤0.05, r=0.826) relations between height and diameter at base of individuals in afforestation based on results of correlation analysis. There were significant differences (p≤0.05) between species and within sampled area of the species for height and diameter based on results of variance analysis.
Keywords: Height, diameter, regeneration, Black pine, Taurus cedar

I. INTRODUCTION

Turkey has 22.3 million ha. forest area cover is about 28.6% of Turkey managed by General Directorate of Forestry of which about half of the area (9.6 million ha) is unproductive [1]. Forest establishment can change difference for countries and regions, while it is including afforestation, reforestation /artificial regeneration, rehabilitation, erosion control, avalanche control, energy forest and rangeland improvement in Turkish forestry [2]. The establishment is the most important way in conversion of unproductive forest to productive, and also to increase present productivity of product forest [2]. It is known that there are many genetical and environmental factors in success of the conversion from seed harvest to plantation or sowing practices, and also condition of afforestation area. The conversion has also valuable contribution to environment. For instance, it was reported that organic matter, phosphorous, nitrogen, clay, dust, field capacity, wilting point and available water capacity were higher in afforested areas which was 15 years than un-afforested areas, while it was opposite for pH, sand, lime and volume weight values [3]. However, investigation on success and contribution of afforestation is very limited [i.e., 3, 4, 5, 6]; especially for the sampled district and other local area [i.e., 3, 4, 5].
Success of the afforestation was examined based on growth data sampled from southern part of Turkey to contribute present and future practices in forest establishment.

II. MATERIAL AND METHOD

The plantations established in 2007 were sampled from three different stand types as pure stand of Anatolian black pine (Pinusnigra-PN), pure stand of Taurus cedar (Cedruslibani- CL) and their mixed stand (CL+PN) in Isparta-Yalvac district of southern part of Turkey (Table 1). Three plantations which of each 200 m^2 were sampled from each stand type(Figure 1). Height (H), diameter at base (D_o) and survival (S) were measured in sampled plantations at end of growing period of 2017.

Table 1. Geographic details of the sampled plantations.

Stand type	Code	Latitude (N)	longitude (E)	Altitude (m)
CL	CL-1	$34^0$23’40””	$42^0$26’58””	1385
	CL-2	$34^0$23’33””	$42^0$26’58””	1340
	CL-3	$34^0$24’07””	$42^0$27’32””	1470
CL+PN	CL+PN-1	$34^0$23’44””	$42^0$27’30””	1450
	CL+PN-2	$34^0$23’47””	$42^0$27’31””	1480
	CL+PN-3	$34^0$23’24””	$42^0$27’31””	1475

PN	PN-1	$34^0$23’16””	$42^0$27’30””	1465
	PN-2	$34^0$23’23””	$42^0$27’30””	1485
	PN-3	$34^0$23’19””	$42^0$27’30””	1460

Figure 2.General views of sampled areas.

Stand types were compared for the performances of growth characteristicsby the following linear model of ANOVA:

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

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

Correlations among the characteristics were also calculated by Pearson’s correlation using SPSS statistical package program [7].

III. RESULTS AND DISCUSSION

Averages of height and diameter were 160.6 cm and 39.4 mm for pure stand of Taurus cedar (CL) (Table 2). They were 161.3 cm, 144.4 cm and 174.5 cm for height, and 38.8 mm, 35.0 mm and 44 mm for diameter at base in sampled plantations of the stand type (Table 2). Survivals were 83%, 69% and 69% in sampled plantations of the stand type.

Table 2.Averages of height (H) and diameter at base (D_0) in CL stands.

	Plantation code and characteristics					
	CL-1 (19)*		CL-2 (18)		CL-3 (20)	
	H	D_0	H	D_0	H	D_0
Average	161.3	38.8	144.4	35.0	174.5	44.0
Minimum	95.0	25.2	75.0	21.5	90	33.2
Maximum	280.0	73.1	210.0	53.1	250	67.3

*; number of measured individuals in the parentheses.

As seen from Table 2, large differences were found within plantation site. For instance, H was ranged and from 95 cm to 280 cm, while D_0 was between 25.2 mm and 73.1 mm in CL-1 (Table 2). The differences were also supported by results of analysis of variance. Results of analysis of variance showed significant differences ($p \leq 0.05$) among sampled plantations of the stand type.
There were positive and significant ($p \leq 0.05$, $r=0.789$) relations between height and diameter at base of individuals in CL stands based on results of correlation analysis. It was also reported in early studies on the species [8, 9].
Averages and ranges of height and diameter were given in Table 3 for pure stand of Anatolian black pine (PN). Sampled plantation PN-1 showed the highest growth performance as 233.7 cm for H and 76.3 mm for D_0 in PN plantations (Table 3).

Table 3.Averages of height (H) and diameter at base (D_0) in PN stands.

	Plantation code and characteristics					
	PN-1 (27)*		PN-2 (38)		PN-3 (24)	
	H	D_0	H	D_0	H	D_0
Average	233.7	76.3	231.8	74.7	240.2	71.3
Minimum	100.0	30.0	160.0	40.0	180.0	50.0
Maximum	340.0	120.0	320.0	110.0	320.0	100.0

*; number of measured individuals in the parentheses.

Averages of height and diameter were 234.7 cm and 74.3 mm respectively, while there were large differences within sampled plantation for the characteristics (Table 3). Results of analysis of variance showed significant differences ($p \leq 0.05$) among sampled plantations of PN stand type. Survivals were 81%, 93% and 73% in sampled plantations of the stand type.
Positive and significant ($p \leq 0.05$, $r=0.758$) relations were found between height and diameter according to results of correlation analysis in the stand type. It was also reported in natural regeneration of the species [10].
In mixed stand (CL+PN) type, averages of height and diameter were 188.6 cm and 57.5 mm, respectively (Table 4). They were 162.4 cm and 37.5 mm for Taurus cedar (Cedruslibani), and 210.8 cm and 74.4 mm for Anatolian black pine (Pinusnigra) (Table 4). It could be said that Pinusnigra had higher growth performance than that of Cedruslibani (Figure 3). It was reported that Pinusnigra showed higher growth performance especially at 5 and 6 years [11]. Survivals were 54%, 64% and 78% in sampled plantations of mixed stand (CL+PN). Results of correlation analysis showed positive and significant ($p \leq 0.05$, $r=0.776$) relations between H and D_0 in the stand type.

Table 4.Averages of height (H) and diameter at base (D_0) in PN stands.

	Plantation code and characteristics					
	CL+PN-1 (19)*		CL+PN-2 (25)		CL+PN-3 (39)	
	H	D_0	H	D_0	H	D_0
Average	170.8	56.8	191.2	63.0	195.6	54.4
Minimum	90.0	20.0	90.0	20.0	70.0	30.0
Maximum	260.0	90.0	280.0	100.0	320.0	100.0

*; number of measured individuals in the parentheses.

Figure 3. Growth performance of the species in mixed stand type.

Statistically significant differences ($p \leq 0.05$) were found among stand types and within stand type according to results ofanalysis of variance (Table 5).

Table 5.Results of analysis of variance for the characters in the stand types.

Characters	Source of variation	Sum of squares	Degrees of freedom	Mean of squares	F value	*P*
H	Between groups	223834.533	8	27979.317	12.51	.000
	Within group	491942.323	220	2236.101		
	Total	715776.856	228			
D_0	Between groups	47026.656	8	5878.332	212.9	.000
	Within group	6075.643	220	27.617		
	Total	53102.298	228			

Stand types and sampled plantations were grouped by Duncan's multiple range test after determination of the statistically significant differences for the characteristics (Table 6).

Table 6.Results of Duncan's multiple range test.

	H			D_0	
Population Code	Averages	Homogenous groups*	Population Code	Averages	Homogenous groups*
CL-2	144.4	a	CL-2	35.0	a
CL-1	161.3	ab	CL-1	38.8	b
CL+PN-1	170.8	abc	CL-3	44.0	c
CL-3	174.5	bc	CL+PN-3	54.4	d
CL+PN-2	191.2	c	CL+PN-1	56.8	d
CL+PN-3	195.6	c	CL+PN-2	63.0	d
PN-2	231.8	d	PN-3	71.2	d
PN-1	233.7	d	PN-2	74.7	d
PN-3	240.2	d	PN-1	76.3	d

Results of the study could be used in management o*; the same letters are significantly different ($p<0.05$).
f present plantation and in establishment of future forest establishment.

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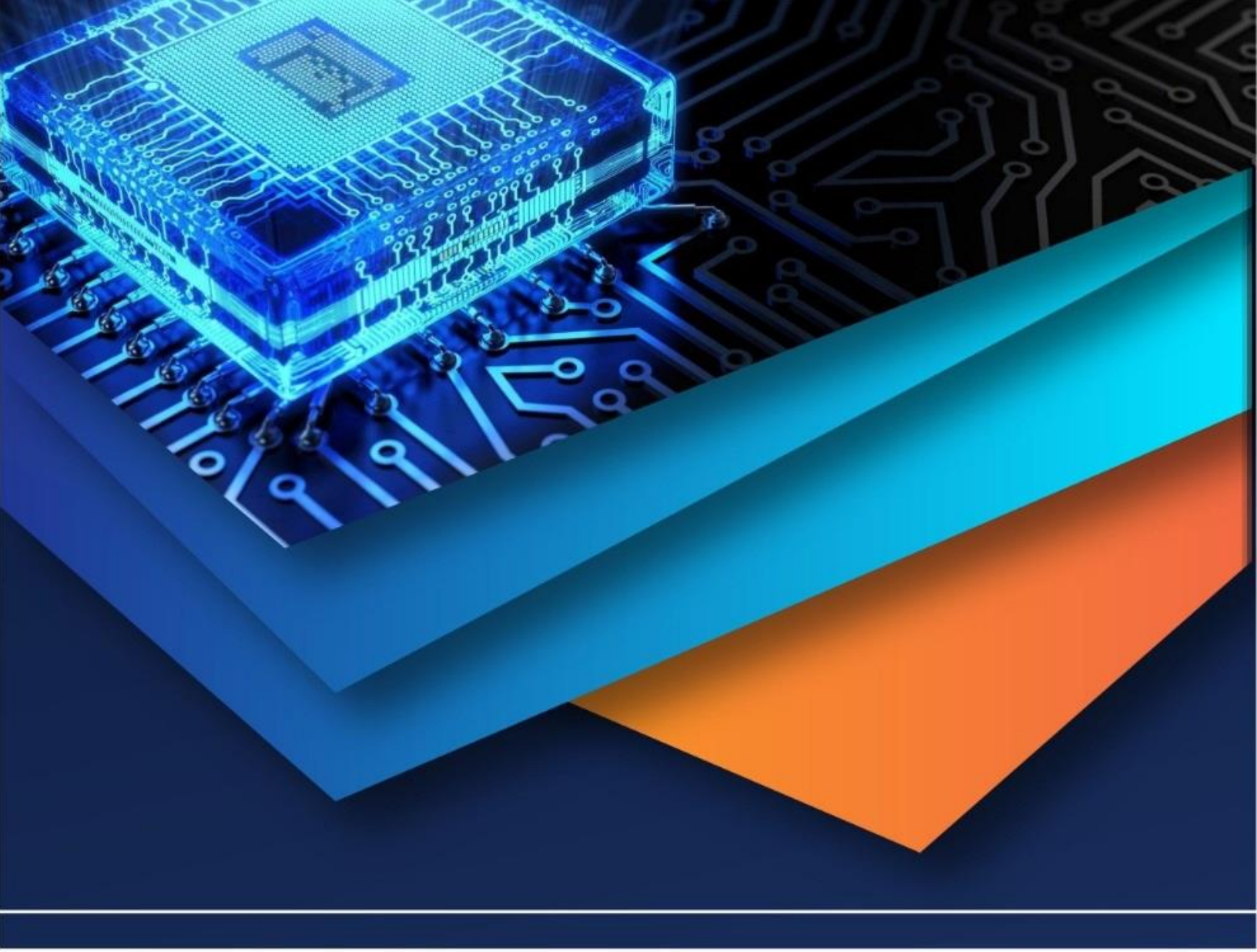

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