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MORPHOLOGICAL CHARACTERISTICS AND QUALITY IN BLACK PINE (*PINUS NIGRA* ARNOLD. SUBSP. *PALLASIANA*) SEEDLINGS

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***Abstract*- This study was carried out on Black Pine (Pinus nigra Arnold. subsp. pallasiana) which is one of the important forest tree species in Turkish forestry to contribute nursery practices and plantation forestry of the species. Seedling height and root-collar diameter were examined in 2+0 and 3+0 year of Black Pine containerized and bare-root seedlings grown at Cankiri and Cerkes Forest nurseries of Turkey at the end of growing period of 2015. Seedling morphology, quality and relation between the characteristics were investigated. Averages of seedling height and root-collar diameter were 8.8 cm, 12.5 cm, 13.3 cm and 27.6 cm; 3.92 mm, 4.51 mm, 5.2 mm and 6.33 mm at 2+0 and 3+0 year of containerized and bare-root seedlings, respectively. There were significant differences (p≤0.05) among seedling types and ages based on results of variance analysis for seedling morphology.**
Distribution of seedlings changed for quality classification, characteristics, seedling age and types. Results of Discriminant analysis were also varied for seedling ages and seedling types.
There was positive and significant (p≤0.05) correlation between seedling height and root-collar diameter based on results of correlation analysis. Results of the study were discussed for nursery practice and plantation forestry of the species. Results of the study should be combined by field stage.

Keywords **-** Black pine; Height; Morphology; Root-Collar Diameter; Seedling

I. INTRODUCTION

Black pine (*Pinus nigra* Arnold. subsp. *pallasiana*) has large natural distribution in Turkish forestry by 4.7 million ha of which 45% to be unproductive. Turkish forests cover about 10.1 million ha unproductive forest which about 46.7% of total forest area [1]. Forest establishment is the most important way in conversion of unproductive forest to productive or increasing of forest land by afforestation, reforestation, artificial regeneration and rehabilitation [2]. Seedling quality and morphology is one of most important factor in plantation forestry and conversion of unproductive forest to productive forest, and to increase quality of present productive forest area [3], and economical and biological successes of plantations.

This study was conducted to examine the seedling morphology and quality on 2+0 and 3+0 year containerized and bare-root Black pine seedlings grown at Cankiri and Cerkes Forest nurseries of Turkey to contribute conversion of unproductive forest to productive forest based on nursery practices and plantation forestry.

II. MATERIAL AND METHODS

Morphological data were collected from 2+0 and 3+0 year bare-root Black pine seedlings (2+0 **BRS**, 3+0 **BRS**) grown from the same provenance at Cankiri (latitude 40° 34' N, longitude 33° 30' E, altitude 750 m) and at the same age containerized seedlings (2+0 **CS**, 3+0 **CS**) grown at Cerkes (latitude 40° 47' N, longitude 32° 55' E, altitude 1130 m) Forest nurseries. Seedling height (**SH**) and root-collar diameter (**RCD**) were measured on 100 seedlings chosen randomly in each age of each seedling type at the end of growing period of 2015.

The seedlings were classified according to the Seedling Quality Classification of Turkish Standard Institute (Table 1) [4].

Table 1. Seedling quality classes of Turkish Standard Institute.

Quality classes	SH (cm)	RCD (mm)	SH+RCD
	2+0		
First class	9≤	2 ≤	9≤ SH + 2≤ RCD
Second class	9> SH ≥7	-	9> SH ≥7 + 2≤ RCD
Cull	7>	2 >	7> SH + 2> RCD
	3+0		
First class	12 ≤	2 ≤	12≤ SH + 2≤ RCD
Second class	12> SH ≥10	-	12> SH ≥10 + 2≤ RCD
Cull	10>	2 >	10> SH + 2> RCD

The quality classes were examined by Discriminant analysis using SPSS statistical package program [5]. Besides Seedling height and root-collar diameter were also correlated by Pearson's correlation.

III. RESULTS AND DISCUSSION

Seedling Morphology

Averages, standard deviation and range of the seedling height and root-collar diameter were given for nursery and seedling types in Table 2. Containerized seedlings showed higher growth performance than bare root seedlings for the characteristics (Table 2, Fig. 1). Similar results were also reported in *Pinus brutia* by [3]. While growth increments were about 42% for seedling height, and 15% from 2+0 to 3+0 year bare-root seedling in Cerkes forest nursery, they were 107% and 22% for containerized seedlings in Cankiri

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forest nursery, respectively (Table 2). There was also about 50% growth difference between containerized and bare-root seedlings (Table 2).

Table 2. Averages, standard deviation and range of the seedling height and root-collar diameter for nurseries and seedling types.

	Cerkes forest nursery				Cankiri forest nursery			
	2+0 BRS		3+0 BRS		2+0 CS		3+0 CS	
	SH	RCD	SH	RCD	SH	RCD	SH	RCD
Average	8.8	3.92	12.5	4.51	13.3	5.20	27.6	6.33
Minimum	6.0	2.00	6.2	2.57	7.0	3.51	12.3	3.91
Maximum	13.0	7.87	18.5	7.21	23.0	8.51	41.1	10.30
St. dev.	1.53	1.01	2.68	0.95	2.83	0.97	4.48	1.13

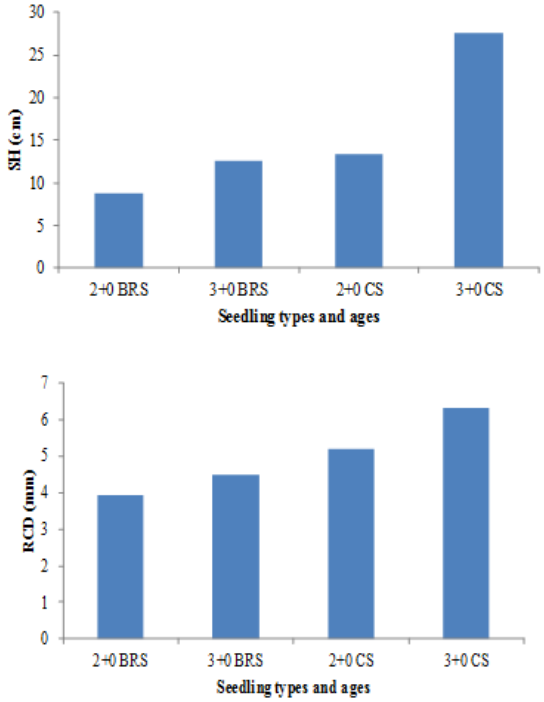

Figure 1. Averages of the seedling height and root-collar diameter for seedling types and ages.

The difference was also supported by significant ($p<0.01$) differences among seedling types and ages based on results of analysis of variance.

There were positive and significant ($p\leq0.05$) relations between seedling height and root-collar diameter based on results of correlation analysis (Fig. 2). It was well accordance with early results in different forest tree species [3, 6, 7]. The significant correlation also showed root-coller diameter could be estimated by seedling height (RCD=0.115SH+3.2069) based on higher R^2 value (0.4389). It could be used in future studies on the species.

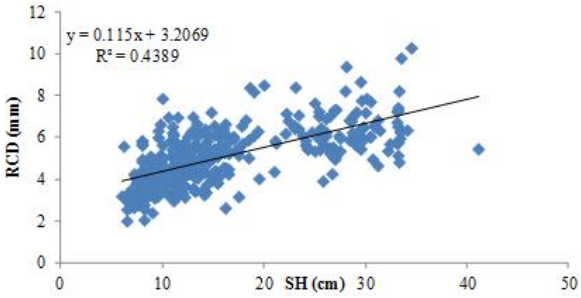

Figure 2. Seedling height and root-collar diameter relation for polled seedling type and ages.

Seedling quality

All seedlings were in quality classification of Turkish Standard Institute for root-collar diameter in all seedling type and age, while 7.2% of seedlings were in cull class for height (Table 3).

Table 3. Distribution (%) of seedlings to quality classes for type and ages.

	SH			RCD	
Seedling type/age	First class	Second class	Cull	First class	Cull
2+0 BRS	42	50	8	100	-
3+0 BRS	54	25	21	100	-
2+0 CS	97	3	-	100	-
3+0 CS	100	-	-	100	-
General	73.3	19.5	7.2	100	-

The quality classes of Turkish Standard Institute were examined by Discriminant analysis. The quality classification was more suitable for containerized seedlings than bare-root seedlings according to results of the analysis (Table 4). Predictions of seedlings were 90% correctly for containerized seedlings and between 30% and 46% for bare-root seedlings (Table 4). Higher correctly prediction for the quality classification of Turkish Standard Institute was also reported in different forest tree species [3, 6, 7, 8]. Root collar diameter was accepted at least 2 mm for all species, ages and seedling types in quality classifications of Turkish Standard Institute for quality seedlings [4]. However, it was known that seedling morphology and quality could change according to age, species and seedling type as emphasized in early studies [9, 10, 11, 12].

Nursery and field performances were combined in some studies carried out on forest tree species to observe the field performance [10, 12, 13].

Table 4. Results of Discriminant analysis**.**

Original groups	Predicted group membership (Count-%)			
	1	**2**	**3**	**Total**
		2+0 BRS		
SH (30%)*				
1	20-47.6	6-14.3	16-38.1	42
2	22-44.0	4-8.0	24-48.0	50
3	2-25.0	-	6-75.0	8
SH+RCD				
(37%)	18-42.9	13-31.0	11-26.2	42
1	16-32.0	14-28.0	20-40.0	50
2	1-12.5	2-25.0	5-62.5	8
3				
		3+0 BRS		
SH (46%)				
1	41-75.9	9-16.7	4-7.4	54
2	21-84.0	3-12.0	1-4.0	25
3	17-81.0	2-9.5	2-9.5	21
SH+RCD				
(39%)	25-46.3	28-51.9	1-1.9	54
1	11-44.0	13-52.0	1-4.0	25
2	10-47.6	10-47.6	1-4.8	21
3				
		2+0 CS		
SH (90%)				
1	87-89.7	10-10.3	-	97
2	-	3-100.0	-	3
SH+RCD				
(90%)	87-89.7	10-10.3	-	97
1	-	3-100.0	-	3
2				

IV. CONCLUSIONS

This study was carried out on nursery stage of the seedlings. Field performance of seedling type, and quality classification should be observed to draw accurate conclusion. Seedling morphology and quality could change according for age, species and seedling type. So, new quality classed should be improved for seedling type for the species.

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