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Effect of Seedling Type in Morphology and Quality of Brutian pine (*Pinus brutia* Ten.) Seedlings

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ABSTRACT

This study was carried out on Brutian Pine (*Pinus brutia* Ten.) which was one of the most important tree species of Turkish Forestry to contribute nursery and plantation practices of the species. Seedling height and root-collar diameter were examined in 1+0 year of Brutian pine containerized and bare-root seedlings grown at Osmaniye Forest Nursery at the end of growing period of 2015. Seedling quality and relation between the characteristics were investigated.

Averages of seedling height and root-collar diameter were 16.61 cm and 4.71 mm in polled seedling type, respectively. While, they were 18.4 cm and 4.86 mm in bare-root seedlings, and 14.79 cm and 4.56 mm in containerized seedlings, respectively. There were significant differences ($p \leq 0.05$) between seedling types based on results of variance analysis. Seedlings were in high quality for both seedling types. The both classification was suitable for the seedlings according to results of Discriminant analysis. There were positive and significant ($p \leq 0.05$) relations between the characters based on results of correlation analysis. Results of the study were discussed for nursery and plantation practices of the species.

Keywords: Afforestation, Height, Growth, Diameter, Nursery, Quality, Brutian Pine

I. INTRODUCTION

Brutian pine or also called Turkish red pine (*Pinus brutia* Ten.) is classified as one of the economically important tree species for Turkish forestry in the "National Tree Breeding and Seed Production Programme because of the its largest distribution by 5.85 million ha of which 45.2% to be unproductive (Anonymous, 2015). Seedling quality and morphology is one of most important factors in forest establishment and conversion of unproductive forest to productive forest, and economical and biological successes of the establishment (Dutkuner and Bilir 2011; Dilaver *et al.*, 2015; Tebes *et al.*, 2015). Results of many studies (i.e., Grossnickle, 2012) showed the relationship between seedlings morphological attributes and planting success. Seedling quality and morphology is getting importance of the species based on global warming and resistance to dry area of the species. However, there are many genetically and environmental effects such as seed source, seedling type, and nursery practice (i.e., Yazici *et al.*, 2011; Yazici and Babalik, 2011; Dilaver *et al.*, 2015; Tebes *et al.*, 2015; Yazici and Babalik, 2016). This study was conducted to examine the seedling morphology and quality on 1+0 year containerized and bare-root Brutian pine seedlings grown at Osmaniye Forest nursery of Turkey to contribute nursery practices of the species.

II. METHODS AND MATERIAL

Seedling height (**SH**) and root-collar diameter (**RCD**) data were collected from 1+0 year bare-root (**BRS**) and containerized (**CS**) seedlings grown at Osmaniye Forest nursery (latitude 36° 20' N, longitude 35° 57' E, altitude 385 m). 150 seedlings chosen randomly were measured in 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) (Anonymous, 1988). Statistically analyses included Discriminant analysis and Pearson's

correlation was carried out by using SPSS statistical package program (Ozdamar, 1999).

Table 1. Seedling quality classes of Turkish Standard Institute.

	BRS		CS		Total	
	SH	RCD	SH	RCD	SH	RCD
Average	18.4	4.86	14.79	4.56	16.61	4.71
Minimum	8.00	2.65	8.00	2.64	8.00	2.64
Maximum	32.00	6.85	32.00	6.71	32.00	6.85
CV (%)	33.3	23.9	28.0	22.2	33.2	24.2

III. RESULT AND DISCUSSION

Morphology

Averages of seedling height and root-collar diameter were 16.61 cm and 4.71 mm in polled seedling types, respectively (Table 2). Growth of bare root seedlings was higher than that of containerized seedlings (Table 2) opposite to early studies in *Pinus brutia* (i.e., Dilaver *et al.*, 2015) and *P. nigra* (i.e., Tebes *et al.*, 2015). However, It was known that there were many genetically and environmental effects such as seed source, seedling type, and practice and condition of nursery (i.e., Yazici *et al.*, 2011; Yazici and Babalik, 2011; Dilaver *et al.*, 2015; Tebes *et al.*, 2015; Yazici and Babalik, 2016). For instance, Yazici and Babalik (2011) reported that 7 day- intervals was the most suitable irrigation interval for *Pinus nigra* seedlings, while Yazici and Babalik (2016) reported that all irrigation density had different effects on seedling morphology for *Cedrus libani* seedlings. 50% growth difference between containerized and bare-root seedlings was reported in *Pinus nigra* seedlings by Tebes *et al.* (2015).

Table 2. Averages, ranges, and coefficient of variation (CV) for seedling height (SH) and root-collar diameter (RCD) in the seedling types.

	BRS		CS		Total	
	SH	RCD	SH	RCD	SH	RCD
Average	18.4	4.86	14.79	4.56	16.61	4.71
Minimum	8.00	2.65	8.00	2.64	8.00	2.64
Maximum	32.00	6.85	32.00	6.71	32.00	6.85
CV (%)	33.3	23.9	28.0	22.2	33.2	24.2

Coefficient of variation (CV) was higher in bare root seedlings than that of containerized for both characteristics (Table 2). The high variation was also seen within seedling type (Figure 1). It could be related to nursery practice such amount of sowed seeds and tending.

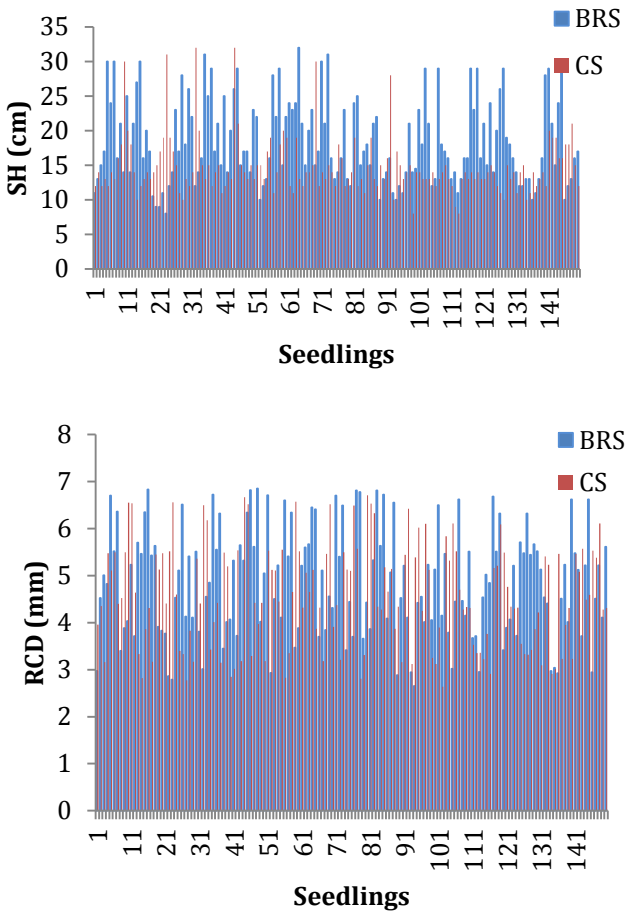

Figure 1. Variation for the characteristics in the seedling types.

The difference between seedling types was also supported by results of analysis of variance (Table 3). Statistically significant ($p<0.01$) differences between seedling types were found according to results of analysis of variance (Table 3).

Table 3. Results analysis of variance for the characteristics in seedling types

Characteristics	Source of variaton	Sum of squares	Degrees of freedom	Mean of squares	F value	P
SH	Between groups	993.720	1	993.720	36.463	.000
	Within group	8121.367	298	27.253		
	Total	9115.087	299			
RCD	Between groups	6.421	1	6.421	5.048	.025
	Within group	379.086	298	1.272		
	Total	385.507	299			

Correlation

Positive and significant ($p\leq0.05$, r=0.690, r=0.622) relations between seedling height and root-collar

diameter were found in both seedling type based on results of correlation analysis (Figure 2).

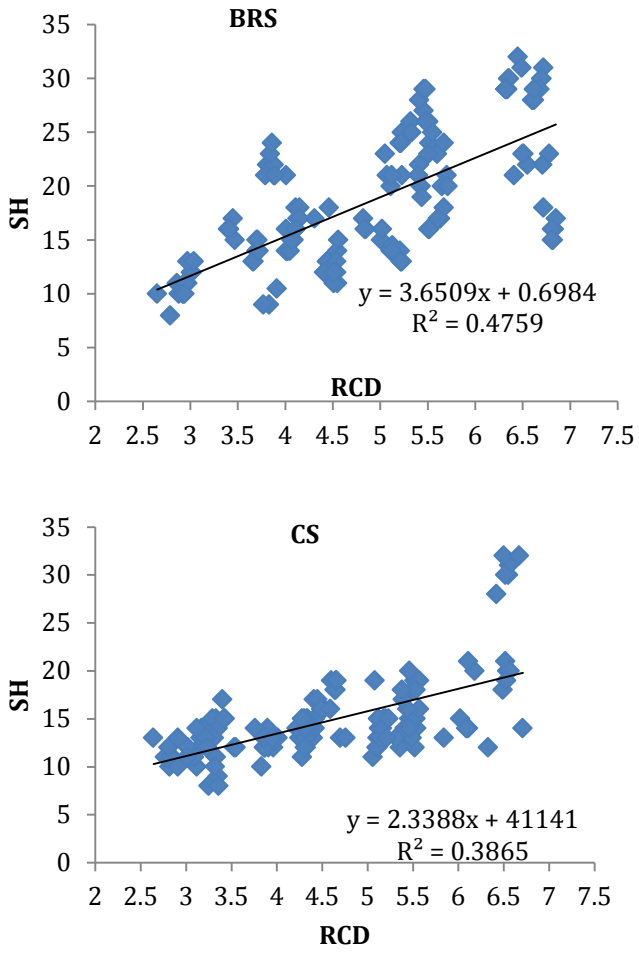

Figure 2. Relationship between seedling height and root-collar diameter for seedling type.

Results of the present study were well accordance with early results in different forest tree species (i.e., Koc and Bilir, 2014; Dilaver *et al.*, 2015; Tebes *et al.*, 2015). The results could be used in future studies on the species.

Quality

All seedlings were in high quality classification of Turkish Standard Institute for root-collar diameter in the seedling types, while it was 90% of seedlings for seedling height (Table 4).

Table 4. Distribution (%) of seedlings to quality classes for types.

	SH			RCD	
Seedling type	First class	Second class	Cull	First class	Cull
BRS	90.0	8.0	2.0	100	-
CS	90.0	9.3	0.7	100	-
Total	90.0	8.7	1.3	100	-

The quality classes of Turkish Standard Institute were examined by Discriminant analysis (Table 5). The quality classification was suitable (90%) for both seedling types according to results of the analysis (Table 5). Similar results were also reported in different forest tree species (i.e., Bilir, 1997; Ucler *et al.*, 2000; Koc and Bilir, 2014; Dilaver *et al.*, 2015; Tebes *et al.*, 2015). However, 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 (Anonymous, 1988). It was known that seedling morphology and quality could change according to age, species and seedling type as emphasized in early studies (Kizmaz, 1993; Gezer *et al.*, 2000; Eler *et al.*, 1993; Koc and Bilir, 2014; Dilaver *et al.*, 2015; Tebes *et al.*, 2015). Beside, growth performances of seedlings at nursey and field stages could change. Nursery and field performances were combined in some studies carried out on forest tree species to observe the field performance (i.e., Kizmaz, 1993; Eler *et al.*, 1993). It could be also suggest for the present study.

Table 5. Results of D*iscriminant analysis*

Original groups	Predicted group membership (Count-%)			
	1	2	3	Total
		BRS		
SH (90%)*				
1	135-100	0	0	135
2	12-100	0	0	12
3	3-100	0	0	3
SH+RCD (90%)				
1	135-100	0	0	135
2	11-91.7	1-8.3	0	12
3	2-66.7	0	1-33.3	3
		CS		
SH (90%)				
1	135-100	0	0	135
2	14-100	0	0	14
3	1-100	0	0	1
SH+RCD (90%)				
1	135-100	0	0	135
2	14-100	0	0	14
3	1-100	0	0	1

*; rate of successful predictions

IV. CONCLUSION

Nursery stage and field performance of seedling type, and quality classification should be observed to draw accurate conclusion. Seedling morphology and quality could change according to seedling type. So, new quality classed should be improved for seedling type for the species.

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