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Morphological variation and quality in Anatolian black pine seedlings

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Abstract: There are many biological and environmental factors in success of forest establishment including afforestation, industrial plantation, and other forestry practices such as nursery technique and provenance. Forest establishment is also getting importance for the Anatolian Black pine [*Pinus nigra* Arnold. subsp. p*allasiana* (Lamb.) Holmboe] because of its widely using in afforestation and higher unproductive forest area, and other practices (i.e., landscape planning). It is known that seedling morphology and quality play key role in biological and economical success in these practices. This study was carried out on 1+0, 3+0 and 5+0 years containerized seedlings grown in Adana-Kicak and Konya-Seydisehir Forest Nurseries to contribute nursery practices (such as grown quality seedlings) and success of forest establishment and other practices For the purpose, seedling height and root-collar diameter of 100 seedlings randomly chosen in each age group were measured at the end of 2017. Averages of seedling height of 1+0, 3+0 and 5+0 years were 9.9 cm, 22.6 cm, and 59.8 cm, respectively, while they were 2.6 mm, 7.8 mm and 14.3 mm for root-collar diameter. Coefficient of variation was the highest at 3 years old seedlings for both characters (27% & 25.3%) but the lowest at 5 years old ones (16% &18.3%). 1% of seedlings for height (height<5cm) and 17% of seedlings for root-collar diameter (diameter<2mm) of 1+0 year seedlings were cull/unsuitable for plantation, while they were no any cull seedlings at age 3 and 5 years according to quality classes of Turkish Standard Institute. Positive and significant ($p<0.05$) correlation was found between height and diameter at all age groups. It emphasized seedling height could be used in the selection of quality seedlings for easy practices by nursery managers.
Keywords: Pine, Reforestation, Seed stand, Seedling

1. Introduction

Anatolian Black pine [*Pinus nigra* Arnold. subsp. p*allasiana* (Lamb.) Holmboe] is an important forest tree species and national breeding program (Koski and Antola 1993) of Turkey by 4.2 million natural distributions of which 33% to be unproductive (OGM, 2022). Forest establishment is the main tool in conversion of unproductive forest to productive forest. Forest establishment is also getting importance for the species because of its widely using in afforestation and higher unproductive forest area. Quality and morphology of seedling material play important roles in success of forest establishment. Anatolian Black pine has also landscape and other plantation purposes except of forestry generally by older seedlings. There could be many biological (e.g., Skroppa and Magussen 1993; Kaya and Temerit 1994; Demirci and Bilir 2001; Ozel *et al*. 2018) and environmental (e.g., Dewald and Feret 1987; Sputh *et al*. 1990; Kizmaz 1993; Yazici and Babalik 2011 and 2016; Deligoz 2011; Yucedag and Gailing 2012; Deligoz *et al*. 2016; Eser and Gulcu 2019; Yucedag *et al*. 2019) factors effective on the success of these purposes. Age could be considered as an important biological factor. While it was taken into consideration such as 2 years for forestry purposes in early studies (e.g., Kizmaz 1993), older seedlings such as 5 years old seedlings have not been studied in the species, yet. Morphology and quality of 1+0, 3+0 and 5+0 years containerized seedlings were examined to contribute nursery and forest establishment and other practices of the species to be grown better quality seedlings.

2. Materials and methods

This study was carried out on 1+0 (originated from a seed stand at 37°37'40" N latitude, 35°14'40" E longitude, 1200 m altitude), 3+0 (originated from a seed stand at 37°51'45" N latitude, 35° 43'30" E longitude, 1450 m altitude) years containerized seedlings grown at Adana-Kicak Forest Nursery (latitude 37° 34' 40" N, longitude 35° 12' 45" E, altitude 980 m), and 5+0 (originated from a seed stand at 37°34'48" N latitude, 31°11'30" E longitude, 1350 m altitude) years containerized seedlings sampled from Konya-Seydisehir Forest Nursery (latitude 37°25'30" N, longitude 31°50'15" E, altitude 1120 m) of Anatolian Black pine. Seedling height (SH) and root-collar diameter (RCD) of 100 seedlings randomly chosen in each age group were measured at the end of 2017.

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Figure1 Sampled seedlings

The seedlings were classified according to quality classes of Turkish Standard Institute (Table 1, Anonymous 1988).

Table 1. Seedling quality classes of Turkish Standard

Quality classes	SH (cm)	RCD (mm)
	1+0 year	
First class	6≤SH	2≤RCD
Second class	6> SH ≥5	-
Cull	5>SH	2>RCD
	3+0 year	
First class	12≤SH	2≤RCD
Second class	12> SH ≥10	-
Cull	10>SH	2>RCD
	5+0 year	
First class	30≤SH	2≤RCD
Second class	30> SH ≥25	-
Cull	25>SH	2>RCD

Seedling height and root-collar diameter were correlated by phenotypic Pearson' correlation (r_p) by Rohlf and Sokal (1995).

$$r_P = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}} \quad (1)$$

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 of the characteristics x and y, respectively.

3. Results and discussion

Large differences were found among individuals within age group for seedling morphology (Table 2, Figure 2). It showed importance of seed sources and selection type to obtain higher morphology and quality in seedlings. Similar results were also reported in different forest tree species (e.g., Skroppa and Magussen 1993; Kaya and Temerit 1994; Demirci and Bilir 2001). Averages of seedling height were 9.9 cm, 22.6 cm, and 59.8 cm at 1, 3 and 5 years old seedlings, respectively, while they were 2.6 mm, 7.8 mm and 14.3 mm for root-collar diameter (Table 2). Coefficient of variation was the highest at 3 years old seedlings for both characters (27% & 25.3%), while it was the lowest at 5 years for the characters (16% & 18.3%) (Table 2). The result emphasized homogeny of older seedlings. Seedling height had higher variation than root-collar diameter (Table 2). The results could be used for the nursery practices of the species.

Table 2 Averages ($\bar{X}$), ranges and coefficient of variation (CV%) of the seedling height (SH) and root-collar diameter (RCD) for the ages

Ages	SH (cm)			RCD (mm)		
	$\bar{X}$	ranges	CV%	$\bar{X}$	ranges	CV%
1+0	9.9	4.0-15.0	26.2	2.6	1.5-4.4	21.5
3+0	22.6	13.0-40.0	27.0	7.8	4.8-14.8	25.3
5+0	59.8	35.0-85.0	16.0	14.3	8.8-24.5	18.3

1% for seedling height (height<5cm) and 17% for root-collar diameter (diameter<2mm) of 1+0 year seedlings were cull/unsuitable for plantation, while they were no any cull seedlings at age 3+0 and 5+0 years according to quality classes of Turkish Standard Institute. However, many seedling characteristics such as fresh and dry weights, ratio between height and diameter could be effective on seedling quality.

Positive and significant (r= 0.522, 0.473 and 0.245, $p<0.05$) correlation was found between height and diameter at all age groups. Similar results were also found in different forest tree species (e.g., Morris *et al*. 1990; Demirci and Bilir 2001; Dilaver *et al*. 2015). It emphasized seedling height could be used in the selection of quality seedlings for easy practices of nursery manager.

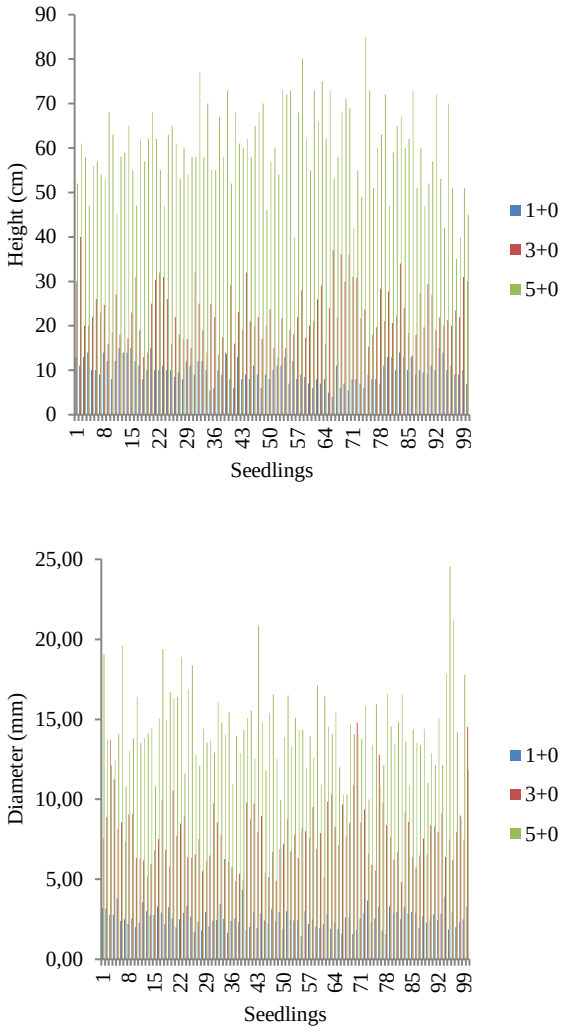

Figure 2 Height and diameter of seedlings for age groups

4. Conclusions

Results of the present study could be used in nursery practices. The study was carried out depending on the limited characteristics of the seedlings from limited seed sources of the species. Further studies should be done by seedlings from many different seed sources.

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