# Determination of Some Morphological Characteristics of 2+0 Years Old Seedlings of Kazdagi Fir (*Abies equi-trojani* Ashers et. Sint.)

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**Abstract**

This study aims to determine some morphological characteristics of 2+0 year seedlings of Kazdagi fir grown at Salihli/Kılıç Forest Nursery in Manisa province. For that reason, 2+0 year, bare-rooted seedlings have been provided. In Kazdagi fir seedlings shoot height (cm), root collar diameter (mm), shoot and root fresh weight (g), shoot and root dry weight (g), shoot height/diameter and shoot/root ratio (dry weight basis) were measured. Some mean values of Kazdagi fir seedlings were found as 9 cm for shoot height, 0.33 cm for root collar diameter, 27.76 for length/diameter ratio, 0.96 for shoot/root ratio (dry weight basis), 3.18 g for root fresh weight, 3.29 g for shoot fresh weight, 1.28 g for root dry weight, 1.09 g for shoot dry weight. In addition, some morphological characteristics of Kazdagi fir seedlings were compared to the Turkish Standards (TS 2265/February 1988). As the result, if root collar diameter and shoot/root (dry weight basis) ratio concerned, 98 % of Kazdagi seedlings were in the Ist quality class. From the shoot height point of view, 30.7% of seedlings were in the Ist and IInd quality classes. When all quality criteria were evaluated together, 8.7% of the Kazdagi fir seedlings used in this study was found to be in the Ist quality class.

**Key words:** Kazdagi fir, Seedling, Morphological characteristics, TSI

## Introduction

Phytogeographically, Turkey occupies an important position in the world from the viewpoint of plant genetic resources and genetic diversity. It is a meeting place for the two centers of diversity and origin: the Near East and the Mediterranean which overlap here. This location together with a great variety of geomorphologic, topographic and climatic features is responsible for its large diversity of habitats and richness of plants vis-à-vis their endemism. The number of taxa lies around 8,745, with 3,300 endemics (Ekim, 2009; Ozturk et al., 2008a; Ozturk et al., 2008b).

Kazdagi (Mt. Ida) is situated in north-west Anatolian part of Turkey. It lies between 39°42' N latitudes and 26°51' E longitudes (Rix, 2002). The mountain forms a natural border between the Marmara and Aegean Regions, but phytogeographically it occupies the transition zone between Euro-Siberian and Mediterranean, with Irano-Turanian impacts in some areas (Koç, 2003). There are 800 plant taxa recorded on Kazdagi. 198 of them are of particular ethno-botanical significance for this mountain. Kazdagi is accepted as one of the most important floristic areas of Turkey (Gemici et.al., 1998; Uysal, 2010). The pseudo-alpine zone consists of 189 specific and infra-specific taxa of vascular plants. A total of 55 endemic taxa (29.10%) were recorded on Kazdagi. Out of these 22 taxa (40%) are restricted only to this area, and 5 taxa are non-endemic but rare in Turkey (Ozturk et al., 2011). Many plant species of commercial value also grow in the area. Among these, geophytes and medicinal plants are especially important. In addition, aromatic and horticultural plants also grow here (Uysal, 2010).

Turkey's total forest area is 21,389,783 ha and out of this, 626,647 ha is formed by fir (*Abies nordmanniana*, *A. bornmülleriana, A. equi-trojani*, and *A. cilicica*) (Anonymous, 2006). According to the management plans (1996-2006) of Çanakkale and Balıkesir Forest Regional Directorates, Kazdagi fir makes totally 3,591.5 ha, with 91.1% mixed (3,309 ha) and 7.9% (282.5 ha) pure forests (Simsar, 2007).

There is no exact consensus about the systematic of Kazdagi fir yet. Some botanists accept Kazdagi fir as a different species, while some others believe it as a subspecies of *Abies nordmanniana* spp. *bornmülleriana* or *Abies pectinata*. But from the pollen morphology point of view, it is assumed that Kazdagi fir is a natural hybrid of *Abies*

*nordmanniana* spp *bornmülleriana* and *Abies cephalonica* (Guinier and Maire, 1908; Flous, 1936; Mattfeld, 1925; Aytuğ, 1959).

Kazdagi fir is described as a narrowly conical tree 20-30 m tall, 1.8-4 m diameter, with a somewhat rounded crown. Bark thick, divided into scaly plates, yellowish grey-brown. Branchlets shiny yellowish, brown to orange-brown, non-pubescent. Buds ovoid, chestnut brown, resinous, scales free at the apex, apex obtuse, 1-1.2 mm diameter. Needles densely set, irregularly disposed, mostly lying forward and crowded on upper side of branchlet, curving upwards on the lower side of the branchlets, grooved above near the base, 15-30 mm length by 1.5-2 mm width, 2 white stomatal strips below in 6-8 lines, apex pointed or obtuse. Female cones cylindrical-ovoid, reddish-brown to dark brown, apex ovoid, 10 cm length by 4-4.5 cm width; bracts long exerted and reflexed, sharp-pointed, lobed. Winged seeds up to 6 mm long and up to 22 mm length (URL2, 2012). The wood is used for pulp or woodworking (Ata, 1975; Ata, 1979).

Kazdagi fir can be found at 400-1,650 m altitudes but generally its optimal distribution is at 1,000-1,300 m. Besides forming pure stands, it makes mixed forest areas together with *Pinus nigra*, *Fagus orientalis*, *Quercus* spp., and *Castanea sativa.* It is known as a fast-growing tree species since when in productive sites it can grow up to 25-33 m height and 50-65 cm diameter in 60-70 years. It grows faster than *A. nordmanniana* Spach., *A. bornmülleriana* Mattf. and *A. cilicica* Carr. It grows on bedrocks of gneiss, diorite-amphibolite, diorite, andesite, schists, granite, phyllite, arkose and schist grafitit. Soil types are sandy, sandy-loam and loamy-sand. It has a tap root system**.** Secondary roots with tap root grow in mature ages. Rotation of rich seed years is 2-3 years (Ata, 1975; Ata, 1979; URL1, 2012; Koç and Aslan, 2011).

Scientific studies about endemic species like Kazdagi fir are important for conservation of biological diversity. Kazdagi fir is suitable for industrial plantations owing to being a fast growing species and its wood uses in various industrial branches (pulpwood, fiber plate, chip plate, plywood) (Tank, 1964).

Biological and economical success of afforestation depends on site conditions, land preparation, planting techniques, planting times and quality of the seedlings (Ayan, 2002; Gezer and Yücedağ, 2006). Seedling morphological characteristics such as length, diameter, shoot and root dry weight are significantly effective on seedling quality (Şevik et al., 2003, Alım et al., 2008). The studies on seedling quality assessment use some parameters such as height, root collar diameter, shoot/root ratio as morphological criteria and root growth potential, plant water potential as physiological criteria (Şevik et al., 2003; Yahyaoğlu and Genç, 2007). However, in order to evaluate the seedling quality, the TSI standards are used in Turkey. The Forestry General Directorates stated in the circular No. 4081 that the Ist and IInd classes of seedlings might be used in afforestation (Anonim, 1986).

This study aims to determine some morphological characteristics of 2+0 years old seedlings of Kazdagi fir called *Abies equi-trojani* Ashers et. Sint. grown at Salihli/Kılıç Forest Nursery in Manisa province. In addition, seedling quality classes were evaluated according to the TSI standard called "The Standard on Coniferous Tree Seedling" (TS 2265/March 1988).

## Material and Method

### Material

In this study, 2+0 years old bare root seedlings of Kazdagi fir were used. Seedlings were grown at Manias/Salihli/Kılıç forest nursery at 990 m altitude on a northeast aspect. Salihli Meteorological Station is the nearest station to Kılıç Forestry Nursery. Table 1 shows the average climate data recorded by this station between 2009 and 2011.

Physical and chemical analyses of the cultivation area are shown in Table 2.

Table 1. Some meteorological data from Salihli meteorological station (Anonim, 2012)

| Year | Meteorological element | |
|---|---|---|
| **2009** | | |
| | Average temperature (ºC) | 17.4 |
| | Average maximum temperature (ºC) | 23.5 |
| | Average minimum temperature (ºC) | 11.7 |
| | Average total rainfall (mm) | 54.3 |
| | Average wind speed (m/s) | 1.7 |
| | Average relative humidity (%) | 64.2 |
| **2010** | | |
| | Average temperature (ºC) | 16.6 |
| | Average maximum temperature (ºC) | 22.7 |
| | Average minimum temperature (ºC) | 12.6 |
| | Average total rainfall (mm) | 105.8 |
| | Average wind speed (m/s) | 1.7 |
| | Average relative humidity (%) | 68.3 |
| **2011** | | |
| | Average temperature (ºC) | 16.1 |
| | Average maximum temperature (ºC) | 22.6 |
| | Average minimum temperature (ºC) | 10.1 |
| | Average total rainfall (mm) | 50.14 |
| | Average wind speed (m/s) | 1.5 |
| | Average relative humidity (%) | 64.6 |

Table 2. Physical and chemical analyses of the cultivation area

| **Depth** | **Physical analysis** | | | | | |
|---|---|---|---|---|---|---|
| **cm** | **Sand** | **Clay** | **Silt** | **Soil type** | | |
| | **%** | **%** | **%** | | | |
| **0-30** | 53.87 | 18.10 | 28.03 | Sandy-loam | | |
| | **Chemical analysis** | | | | | |
| **Depth** | **Total $CaCO_3$** | **ECx$10^{-3}$** | **pH** | Organic matter | | |
| **cm** | % | mmhos/cm | | (%) | | |
| **0-30** | slightly | 0.054 | 7.42 | 1.466 | | |
| | **Macro element** | | | | | |
| **Depth** | **N** | **P** | **K** | **Ca** | **Mg** | **Na** |
| **cm** | **%** | **ppm** | **ppm** | **ppm** | **ppm** | **ppm** |
| **0-30** | 0.089 | 17.44 | 330 | 844 | - | 125 |

**Method**

150 seedlings were randomly selected from the cultivation area. Shoot height (cm), root collar diameter (mm), root height (taller root height) (cm), shoot and root fresh weight (g), shoot and root dry weight (g) were assessed. After these measurements, slenderness (length/diameter) and shoot/root ratio (dry weight basis) of seedlings were determined. The samples for dry weight measurements were oven-dried at 105 ºC for 24 h and then weighed. The morphological characteristic measurements of the seedlings were made by the same persons for uniformity. Seedling heights, root collar diameters and weights were measured with a 1.0 mm, 0.05 mm and 0.001 g precision, respectively.

Quality classes of seedlings were assessed by using the TSI (TS 2265/March 1988). This standard prepared for bare root fir seedlings is shown in Table 3.

Table 3. 2+0 years old Kazdagi fir seedling quality classes according to TSI (Anonim, 1988)

| Seedling Classes | Seedling Characteristic |
|---|---|
| Ia | RCD min. 2 mm, SH min.12 cm, S/R< less than 3/1 |
| Ib | RCD min. 2 mm, SH min.12 cm, 3/1<S/R<4/1 |
| IIa | RCD min. 2 mm, SH min.10 cm, S/R< less than 3/1 |
| IIb | RCD min. 2 mm, SH min.10 cm, 3/1<S/R<4/1 |

*RCD: root collar diameter, SH: shoot height, S/R: shoot/root ratio (dry weight basis)

**Results and Discussion**

Statistics of some morphological characteristics of Kazdagi fir seedlings are given in Table 4. Some mean values of Kazdagi fir seedlings were found as 9 cm for shoot height, 0.33 cm for root collar diameter, 27.76 for length/diameter ratio, 0.96 for shoot/root ratio (dry weight basis), 3.18 g for root fresh weight, 3.29 g for shoot fresh weight, 1.28 g for root dry weight, 1.09 g for shoot dry weight.

Table 4. Statistics of some morphological characteristics of Kazdagi fir seedlings

| Species | Statistical values | Shoot height (cm) | Root collar diameter (cm) | Length/ Diameter | Root fresh weight (g) | Shoot fresh weight (g) | Root dry weight (g) | Shoot dry weight (g) | Shoot/ Root (Dry weight basis) |
|---|---|---|---|---|---|---|---|---|---|
| Kazdagi fir | **Minimum** | 4.5 | 0.19 | 12.44 | 0.6 | 0.7 | 0.3 | 0.3 | 0.12 |
| | **Maximum** | 14.6 | 0.51 | 45.32 | 8.1 | 9.7 | 3.6 | 3.3 | 4.5 |
| | **Average** | 9 | 0.33 | 27.76 | 3.18 | 3.29 | 1.28 | 1.09 | 0.96 |
| | **Standard deviation (S)** | 2.06 | 0.7 | 5.31 | 1.41 | 1.63 | 0.60 | 0.52 | 0.53 |
| | **Coefficient of variation (Cv %)** | 22.85 | 20.42 | 19.13 | 44.41 | 49.50 | 48.89 | 47.68 | 55.61 |

**The seedling shoot height quality classes according to TSI**

8.7 % of Kazdagi fir seedlings according to shoot height were found in the I$^{st}$ quality class. 22 % of Kazdagi fir seedlings were found in the II$^{nd}$ quality class and 69.3 % of Kazdagi fir seedlings were found in the III$^{rd}$ quality class (rejected seedlings) (Table 5).

Table 5. The seedling shoot height quality classes according to TSI

| Classes | Number | (%) |
|---|---|---|
| I$^{st}$ class SH≥12 cm | 13 | 8.7 |
| II$^{nd}$ class 10 ≤SH<12cm | 33 | 22 |
| III$^{rd}$ class SH<10 cm (rejected seedling) | 104 | 69.3 |

**The seedling root collar diameter quality classes according to TSI**

98 % of Kazdagi fir seedlings were found to be in the I$^{st}$ quality class according to root collar diameter and 2 % in the II$^{nd}$ quality class (rejected seedling). Data are given in Table 6.

Table 6. The seedlings root collar diameter quality classes according to TSI

| Classes | Number | (%) |
|---|---|---|
| Ist class RCD≥2 mm | 147 | 98 |
| IInd class RCD<2 mm (rejected seedling) | 3 | 2 |

**The seedling shoot/root quality classes according to TSI (dry weight basis)**

98 % of Kazdagi fir seedlings shoot/root ratio (dry weight basis) was found as I$^{st}$ quality. 1.3 % of them as II$^{nd}$ quality and 0.7 % as III$^{rd}$ quality (rejected seedling) (Table 7)

Table 7. The seedlings shoot/root ratio (dry weight basis) quality according to TSI.

| Classes | Number | (%) |
|---|---|---|
| Ist class S/H<3 | 147 | 98 |
| IInd class 3≤S/H≤4 | 2 | 1.3 |
| IIIrd class S/H>4 (rejected seedling) | 1 | 0.7 |

**The seedling shoot height and root collar diameter quality classes according to TSI**

When shoot height and root collar diameter quality were evaluated together, four quality classes were found. The percentages of these classes are: 8.7 % in the I$^{st}$ class, 22 % in the II$^{nd}$, 67.3 % in the IIIrd and 2 % in the IV$^{th}$ (rejected seedling) quality class. Data are given in Table 8.

**The seedling shoot height, root collar diameter and shoot/root ratio (dry weight basis) quality classes according to TSI**

The seedling shoot height, root collar diameter and shoot/root ratio (dry weight basis) quality establishes were done for 149 seedling samples. Out of these, 13 (8.7%) were found to be in the I$^{st}$ quality class. Results are shown in Table 9.

Table 8. The seedling shoot height and root collar diameter quality classes according to TSI

| Classes | Number | (%) |
|---|---|---|
| I$^{st}$ class SH≥12 cm, RCD≥2 mm | 13 | 8.7 |
| II$^{nd}$ class 10 ≤SH<12, RCD≥2 mm | 33 | 22 |
| III$^{rd}$ class SH<10, RCD≥2 mm | 101 | 67.3 |
| IV$^{th}$ class SH<10, RCD<2mm | 3 | 2 |
| Total seedling number | 150 | |

Table 9. The seedling shoot height, root collar diameter and shoot/root ratio (dry weight basis) quality classes according to TSI

| Classes | Number | (%) |
|---|---|---|
| I. class SH≥12 cm, RCD≥2 mm, S/R<3 | 13 | 8.7 |
| II. class SH≥12 cm, RCD≥2 mm, 3≤S/R≤4 | - | - |
| III. class SH≥12 cm, RCD≥2 mm, S/R>4 | - | - |
| IV. class SH≥12 cm, RCD<2mm, S/R<3 | - | - |
| V. class SH≥12 cm, RCD<2mm, 3≤S/R≤4 | - | - |
| VI. class SH≥12 cm, RCD<2mm, S/R>4 | - | - |
| VII. class 10 ≤SH<12, RCD≥2 mm, , S/R<3 | 33 | 22 |
| VIII. class 10 ≤SH<12, RCD≥2 mm, 3≤S/R≤4 | - | - |
| IX. class 10 ≤SH<12, RCD≥2 mm, S/R>4 | - | - |
| X. class 10 ≤SH<12, RCD<2mm, S/R<3 | - | - |
| XI. class 10 ≤SH<12, RCD<2mm, 3≤S/R≤4 | - | - |
| XII. class 10 ≤SH<12, RCD<2mm, S/R>4 | - | - |
| XIII. class SH<10, RCD≥2 mm, S/R<3 | 98 | 65,8 |
| XIV. class SH<10, RCD≥2 mm, 3≤S/R≤4 | 1 | 0,7 |
| XV. class SH<10, RCD≥2 mm, S/R>4 | 1 | 0,7 |
| XVI. class SH<10, RCD<2mm, S/R<3 | 3 | 2 |
| XVII. class SH<10, RCD<2mm, 3≤S/R≤4 | - | - |
| XVIII. class SH<10, RCD<2mm, S/R>4 | - | - |
| Total seedling number | 149 | |

The quality classes of seedlings are evaluated in various studies according to the TSI standards (Genç et al., 1999, Gezer et al., 2000, Üçler et al., 2000; Şevik et al., 2003,

Demircioğlu et al., 2004; Avanoğlu et al., 2005). The quality classes of Kazdagi fir seedlings were evaluated according to the TSI standards in this study.

If only the seedling shoot height be evaluated in quality classes, 69.3 % of seedlings of Kazdagi fir used in this study will be unacceptable for afforestation. Some studies emphasized that root collar diameter is more important than other criteria in the classification of seedling quality (Şimşek, 1987). The study on *Pinus radiata* and *Pseudotsuga menziesii* seedlings expressed that root collar diameter was the best indicator of quality (Duryea, 1984). Genç et al. (1999) found that root collar diameter is the basic quality criteria for *Pinus nigra* Arn. subsp. *pallasiana*. In this study, 98% of fir seedlings was found to be in the I$^{st}$ quality class according to their root collar diameter.

In the seedling quality classification, shoot/root (dry weight basis) ratio is one of the most common values among the others. When this ratio is 2 or 3, it is considered that the survival percentages of the seedlings are higher in arid areas (Cleary and Greaves, 1979). In this study, the shoot/root ratio was found between 0.12 and 4.5 and 98% of seedlings were less than 3.

Alkan (2002) expressed that seedling quality criteria such as shoot height and root collar diameter should be evaluated together. Likewise, in this study, shoot height, root collar diameter and shoot/root (dry weight basis) ratio was evaluated together. When the shoot height, root collar diameter and shoot/root ratio (dry weight basis) are evaluated together, the number of seedlings in the I$^{st}$ quality class is found to be less than when these criteria are evaluated separately.

## Conclusion

In this study, Kazdagi fir seedlings were determined according to some morphological characteristics such as shoot height, root collar diameter, shoot and root fresh weight, shoot and root dry weight, length/diameter and shoot/root ratio (dry weight basis). As the result, when root collar diameter and shoot/root (dry weight basis) ratio concerned, 98% of Kazdagi seedlings were in the Ist quality class. From the shoot height point of view, 30.7% of seedlings were in the Ist and IInd quality classes. When all quality criteria were evaluated together, 8.7% of the Kazdagi fir seedlings used in this study were found to be in the Ist quality class.

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