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Full Length Research Paper

Effect of stratification treatments on germination of *Sorbus torminalis* L. Crantz (wild service tree) seeds with different origins

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Seed characteristics of wild service tree's (*Sorbus torminalis* L. Crantz) fruits collected from 4 different regions of the Black Sea region in Turkey and their germination ratio in different environments were considered. The fruits used in the study were collected from trees that are very close to each other. Collected seeds were subjected to cold stratification of +2°C in an environment of 50% peat + 50% perlite in 4 different periods. Measurements done on the seeds used in the planting process show differences with respect to origins. The average size of seeds of Artvin origin was 6.68 mm, average dimater was 3.16 mm and 1000 grains weight was 2.81 g; average size of seeds of Trabzon origin was 6.04 mm, average diameter was 3.67 mm and 1000 grains weight was 3.70 g; average size of seeds of Bartın origin was 5.23 mm, average diameter was 2.88 mm and 1000 grains weight was 1.98 g, while the average size of seeds of Samsun origin was 5.59 mm, average diameter was 3.36 mm, 1000 grains seed weight was 3.07 g. The seeds used in this study were sown in 3 different mediums at the beginning of April. When ratios of seed germination were analyzed, maximum germination occured in the 4 months stratification. Although *S. torminalis* L. Crantz seeds have germination ratio of 5 – 6%, in this study the maximum germination was seen in seeds from Trabzon origin which were planted in an environment of 80% peat + 20% stream sand, with a ratio of 96.6%, while the minimum germination was seen in Bartın origin seeds that were planted in an environment of 80% peat + 20% stream sand, with a ratio of 13.3%.

Key words: *Sorbus torminalis* L. Crantz, wild service tree, germination, stratification, seed.

INTRODUCTION

The wood of wild service tree (*Sorbus torminalis* L Crantz), which belongs to Rosaceae family, is highly valuable in the furniture industry (Drapier, 1993; Wilhelm and Ducos, 1996; Miko and Gazo, 2004). Its efflorescent fruits are also used in the pharmaceutical industry (Tsitsa-Tzardi et al., 1992; Chalupa, 2002). The white flowers are quite beautiful and the fruit can be eaten by humans and wild animals (Chalupa, 2002). These bring it to the foreground of planting in landscape architecture (Shoemaker and Hargrave, 1936; Chalupa, 1992).

The yield of *S. torminalis* L. Crantz seeds is 3-5% and the plant germinates in two to three years. This reveals a major challange of wild service tree (Baytop, 1998; Simanek, 1977; Kausch-Blecken von Schmeling, 1992).

Gültekin et al. (2007) reported that the most appropriate stratification period before planting *Sorbus domestica* L., *S. torminalis* L. Crantz and *Sorbus umbellata* (Desf.) Fritsch is 60 day long, cold stratification. Miko and Gazo (2004) evaluated the ratio of seed characteristics of *S. domestica* L. furit whose population were chosen from 2001 to 2003 in its germination areas. It was stated that there is a positive relationship between germination rate and fruit weight while there is a negative ralationship between 1000 grains weight and germination ratio.

At the beginning of December 1999, Takos (2003) planted seeds of 15 natural forest tree species without subjecting them to any pre-processing for determination of germination ratio of seeds. While the seeds of *Malus sylvestris* Mill germinated with 96%, the ratio of *Fraxinus ornus* L. was 88%, *Celtis australis* L. and *Cornus sanquinea* L. were 79% and *Euonymus europaeus* L. was

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Table 1. Altitude, location and gathering date of *Sorbus torminalis* L. Crantz.

Gathering date	Location	Altitude
16/11/2008	Artvin (1260 m)	(41°42′38, 551″ E, 41°13′38, 685″ N)
10/9/2007	Bartın (545 m)	(32 °23′10″ E, 41 °04′57″ N)
28/10/2007	Samsun (60 m)	(35°35′10″ E, 41°31′00″ N)
16/10/2007	Trabzon (66 m)	(39°49′47, 365″ E, 40°58′52, 387″ N)

Seed storage conditions until sowing was 2°C cold stratification.

67%. On the contrary, *Laurus nobilis* seeds germinated with a ratio of 11%, *S. torminalis* (L.) Crantz with a ratio of 1% and *Prunus spinosa* L. with a ratio of 0%. Scutcheon and embryo were not active in *S. torminalis* (L.) Crantz seeds and this decreased the ratio of germination percentage.

Some chemicals contained rowanberry blocks water and gas exchange of plant embryons. It could also affect growth. This directly creates barriers to germination of seed (Baytop, 1998; Bignami, 2000). *S. torminalis* L. Crantz is propagated mainly by seeds, that before germination must be stratified for long period (for 5-7 months in moist sand) (Chalupa, 2002). In most of the nurseries, seeds are either stratified or planted in autumn/ spirng according to their dormancy (Hartmann et al., 1997). In general, larger seeds have an advantage over smaller ones in germination even in seedling survival and growth (Baskin and Baskin, 1998; Navarro and Guitian, 2003). It seems that delayed seed germination is related to seed physiology and tree age (Espahbodi et al., 2007).

Although temperature, rainfall and soil conditions are suitable for the cultivation of rowan in the urban centres, rowan-found in Turkey, especially in the Eastern Black Sea region- is used in rural landscape. The germination of wild service tree (*S. tominalis* L. Crantz), which is found scattered in the forest flora of East-West Black Sea forest flora was examined by applying cold stratification and different planting environments. The seed's ratio of germination as well as the effectiveness of the morphological structure was checked. This showed no significant production of this specie and as such was not often used in landscsape design. By determining the appropriate method of germination of this species, it is intended that more use of it could be encourage. Thus, the continuity of this type, whose existence is in danger as result of misuse, will be provided.

MATERIALS AND METHODS

The wild service tree (*S. torminalis* L. Crantz) seeds used in the study were obtained from 4 different areas in the Black Sea region of Turkey (Artvin, Bartın, Samsun and Trabzon) (Table 1). Fruits were collected from approximately 4 trees and mixed up with each origin. The testing has carried out in the greenhouse of Black Sea Technical University of Forestry. The average altitude of the nursery is 212 m. The collected seeds were manually cleaned. According to rules of ISTA, 1000 grains of each origin were determined (Ista, 1993).

Until being taken for stratification, the obtained seeds were stored at room temperature, in open containers. Some morphological measurements such as 1000 grains weight as well as their lengths and diameters were made. The seeds were then placed in gauzes which conducts water. In this study, 3 replicates and 30 seeds for each replicate were used. The number of seeds taken for stratification was 4720 and the number of seeds left for checking was 600. The seeds were placed in 48 h long flowing water before being placed in the stratification environment, in order to increase their water holding capacity. The seeds taken for stratification were immediately placed in special closed containers in which there is a mixture of 50% peat + 50% perlite and then taken for stratification at +2°C for 1, 2, 3 and 4 months (Var and Bekci, 2006; Miko and Gazo, 2004). Mixture of peat-perlite that were used in stratification, was sterilized at 121°C in order not to become moldy. In order to plant the seeds simultaneously, first of all 4 months old then 3, 2 and 1 month old seeds were taken for stratification, respectively. During this process, seeds were checked weekly for ventilation and water requirement. The seeds of *S. torminalis* L. Crantzwhich include those taken for stratification and those that were not (for checking) were planted in containers as 3 times recursived, at the Karadeniz Technical University (KTU), Faculty of Forestry green-house on the 18th 0f April, 2008. Planting was done in 3 different environments;

(1) 80% Peat + 20% stream sand (pH: 6.2; salty: 475).
(2) 60% Forest soil + 20% stream sand + 20% perlite (pH: 5.6; salty: 167).
(3) 60% Stream sand + 40% Anatolian larch (pH:5,9; salty:486).

Seeds were planted doubly in containers with a depth of 5 mm and an appreciable distance between them. Shortly after the planting process was over, irrigation was started. Due to the 60 - 70% change (Yahyaoğlu, 1993) in water holding capacity of germination bed, containers were watered on the first days of planting, twice a day; early in the morning and late evening.

This year's climatic conditions (temperature and rainfall) in the last 30 years in terms of the average temperature and precipitation data is given in Table 2. These statistics were obtained from Trabzon Weather Stations, which is about 1.5 km away from KTU, Faculty of Forestry greenhouse. It was determined that temperature and rainfall in April, when planting was done, was more than that obtained in March and May. While the measurement of the germination of seeds was completed, light intensity of planting environment (penumbra environment) and external environment were compared by measurement (Figure 1). In order to provide growth of the seeds generated in May - July in a healthy manner and not to allow them be exposed to more water loss until vegetation period, a sheltered place was chosen for plantation area.

Properties of fruit and seed

Weight of 1000 grains was measured for each origin. Studies

Table 2. Temperature and rainfall data of Trabzon weather stations.

Months	January	February	March	April	May
Precipitation amount (mm) (2008)	79.7 (7.8)[1]	32.1 (64.8)	32.9 (59.0)	38.1 (59.6)	6.0 (3.0)
Average temperature (°C) (2008)	3.8 (7.4)	4.8 (7.0)	12.3 (8.3)	14.1 (12.0)	14.9 (15.8)
Maximum temperature (°C) (2008)	6.9 (10.9)	8.0 (10.6)	17.9 (12.0)	18.4 (15.9)	17.8 (19.0)
Minimum temperature (°C) (2008)	1.4 (4.5)	2.4 (4.1)	7.9 (5.4)	10.6 (8.8)	11.4 (12.7)

[1]The data in brackets show average valuation between the years 1975 – 2005.

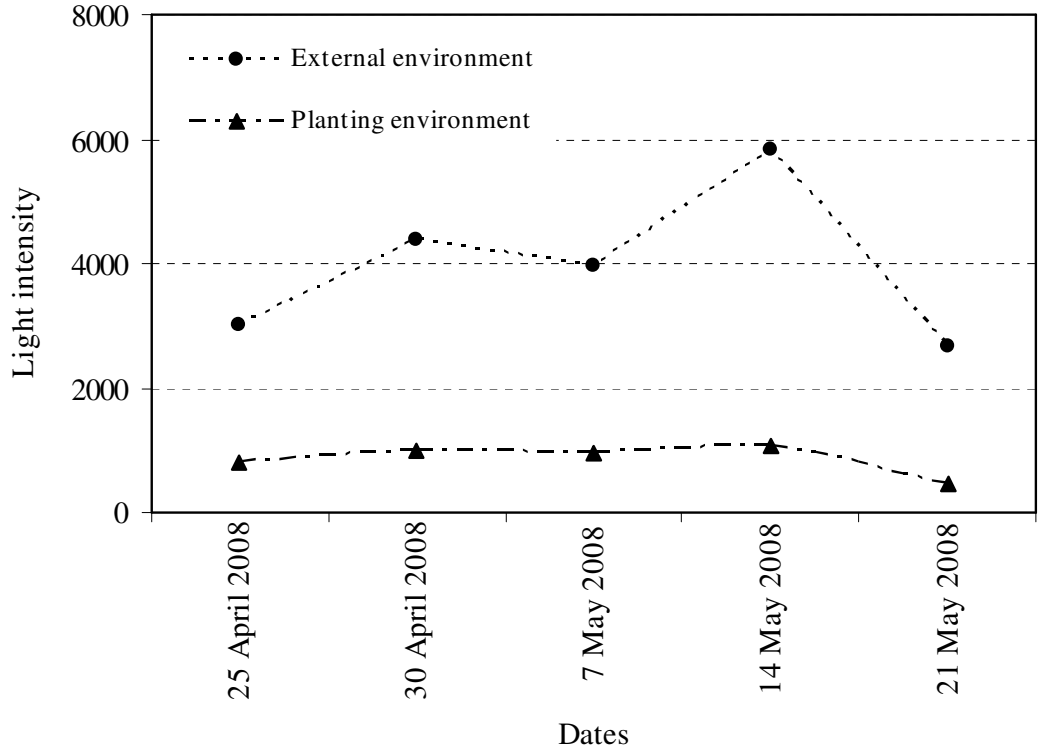

Figure 1. Light intensity diagram.

(Gültekin et al., 2007) about the ratio of seed germination in the different types of rowan show that among the types of rowan which was tested, 1000 seed weight is parallel to Trabzon and Samsun origin seeds. Appearance of seeds were obtained from different tests, in the study was also compared (Figure 2).

RESULTS AND DISCUSION

Nursery germination

As a result of seed length and diameter examination, Artvin origin seeds were the longests while Trabzon origin ones had the highest diameter. When the raito of germination of seeds in 4 months stratification was examined, the most germination was seen in the seeds of Trabzon origin, with 96.6%, that was planted in an environment of 80% peat + 20% stream sand whereas the least germination was seen in Bartın origin seeds, with 13.3 %, that was planted in an environment of 80% peat + 20% stream sand. Among the 4 months stratification, the most germination was seen in Samsun and Trabzon (with the highest diameter) origin.

As a result of the count of tested seeds that were obtained from maple-leaf rowanberry and determining the average efficiency of seeds, at least 2 up to 4 seeds are obtained from each of 4 origin. Diameter and length of seeds that were used in the experiment with different origins are shown in Table 3.

While the most germination with 53.3% was seen in Samsun origin seeds that were planted in an environment of 60% forest soil + 20% stream sand + 20% perlite, the minimum germination was seen in Bartın origin seeds that were planted in an environment of 60% stream sand + 40% anatolian larch, 60% forest soil + 20% stream sand + 20% perlite. While a germination ratio of 4% - 3% was seen in Trabzon and Samsun origin seeds that were

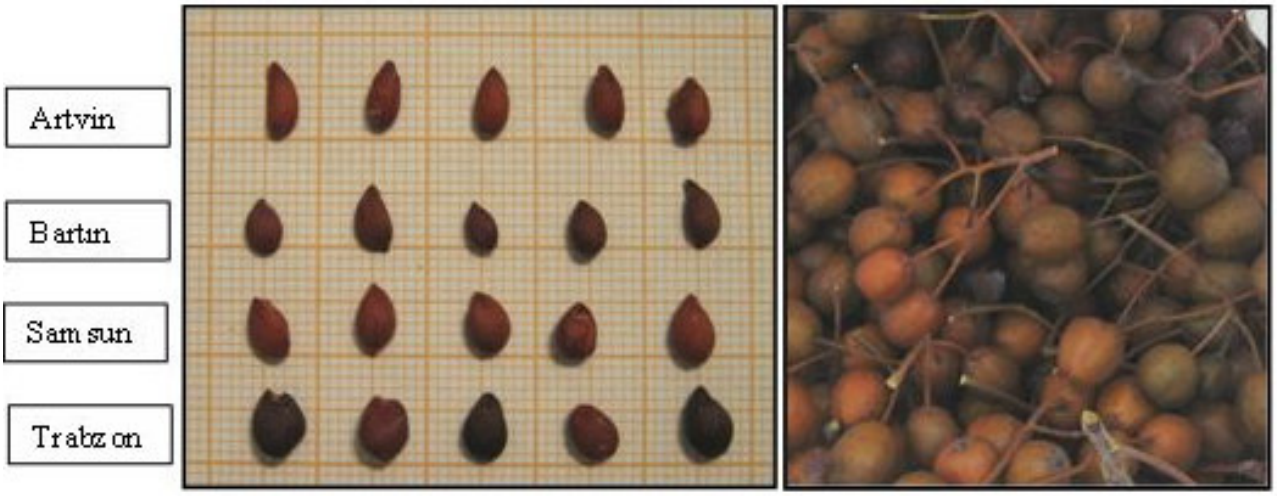

Figure 2. A view from *S. torminalis* L. Crantz that has been used for the study.

Table 3. Diameter and length ratio of origins.

Origin	Height (mm)	Diameter (mm)	Weight of 1000 grains (g)
Artvin	6.68	3.16	2.81
Trabzon	6.04	3.67	3.70
Bartın	5.23	2.88	1.98
Samsun	5.59	3.36	3.07

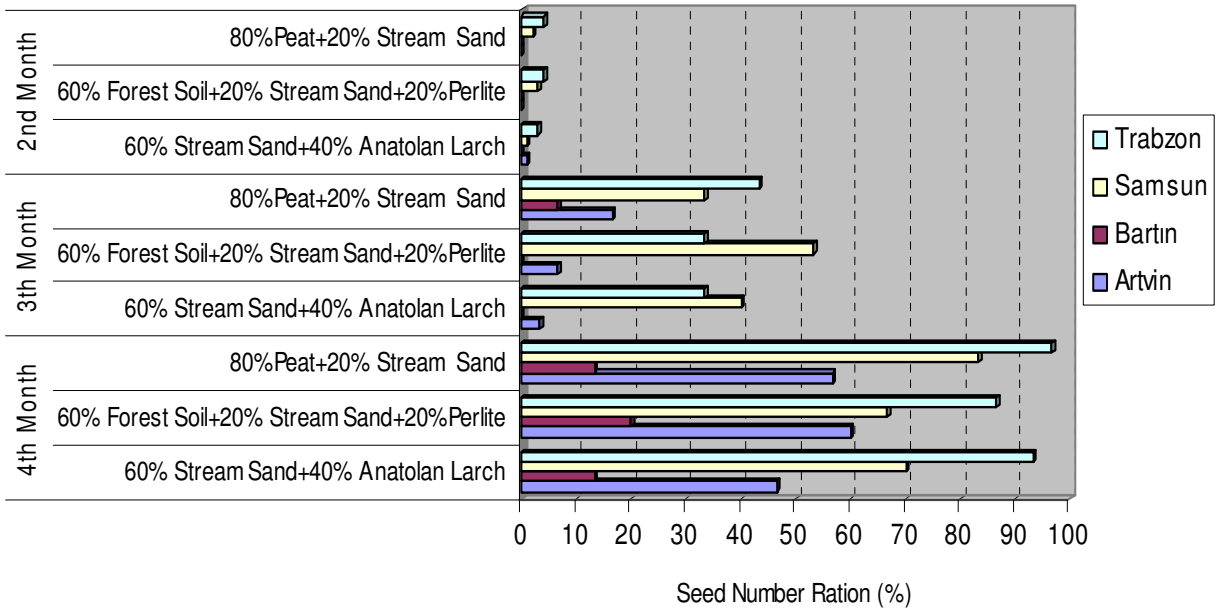

Figure 3. Germination graphics of the seeds that have been taken to 2nd, 3th, 4th month long stratification.

taken for 2 months stratification, there was no germination seen in the seeds which were taken for 1 month stratification for the purpose of checking. These rates are given in Figures 3 and 4. The result of variance analysis

Figure 4. Some view from germinated seeds.

Table 4. Classification of data according to variance analysis.

Source	Type III sum of squares	df	Mean square	F	Sig.
Model	85090.318(a)	36	2363.620	73.524	0.000
Origin	12625.735	3	4208.578	130.914	0.000
Stratification	19609.963	2	9804.982	304.999	0.000
Germination environment	224.001	2	112.000	3.484	0.036
Origin * Stratification	2656.071	6	442.679	13.770	0.000
Origin * Germination environment	148.825	6	24.804	0.772	0.595
Stratification * Germination environment	91.865	4	22.966	0.714	0.585
Origin * Stratification * Germination environment	693.131	12	57.761	1.797	0.065
Error	2314.626	72	32.148		
Total	87404.944	108			

among germinated seeds' origin, stratification, planting environment and reiteration ratio are given in Table 4.

According to the variance analysis that was applied to germinated *S. torminalis* L. Crantz seeds, there is a positive relationship among them. This is because the significance level of seeds' origin, stratification, germination environment and origin/stratification are smaller than 0.05. According to the Duncan test done, in order to classify 4 different origin's germination, the least germination was seen in Bartın origin seeds and the most germination was seen in Trabzon origin seeds (Trabzon > Samsun > Artvin > Bartın) (Table 5). Considering these results, origin differences had a positive effect on germination. The percentage of germination of Samsun

Table 5. Classification of origin differences according to Duncan test.

Origin differences	N	Subset			
	1	2	3	4	1
Bartın	27	6.1586			
Artvin	27		16.6812		
Samsun	27			27.9529	
Trabzon	25				34.4440

Table 6. Classification of stratification time according to Duncan test.

Stratification time (months)	N	Subset		
	1	2	3	1
2	36	5.8144		
3	36		19.4496	
4	36			38.6636

Table 7. Classification of planting areas according to Duncan test configuration.

Germination environment	N	Subset	
	1	2	1
60% Stream sand + 40% anatolian larch	36	19.3851	
60% Forest soil + 20% stream sand + 20% perlite	36	21.6929	21.6929
80% Peat + 20%stream sand	36		22.8495

and Trabzon seeds are more than others, bacause its weight of 1000 grains and diameter was greater.

Considering the effects of stratification on germination, focusing on the Duncan test, the best germination was seen in seeds that were taken for stratificaiton for 4, 2 and 3 month periods. In the seeds that were taken for stratification for 1 month, no germination was seen (Table 6). Germination environments had effects on the germination of seeds. According to Duncan test configuration, the best germination environment consists of 80% peat + 20% stream sand. This was followed by the environment of 60% forest soil + 20% stream sand + 20% perlite (Table 7).

The highest germination rate of the 4 origin was obtained from seeds that were taken for stratification for 120 days. After 4 months stratification period, seeds were found to have completed pre-germination. It was seen that, seeds which have completed their pre-germination, lose their ability to germinate in the event of staying in stratification longer. The biggest factor of pre-germinated seeds in losing the ability to germinate is that they cannot be adapted to the planting environment and be affected from water in stratification environment. In a study carried out by Gültekin et al. (2007), *S. torminalis* L. Crantz comes after adjuration of 105 day long stratification. 3 months stratification is determined to be sufficient for other types of So*rbus* (Figure 5). No germination was found in the seeds (control) that were planted without being stratified. Thus, before planting of *S. torminalis* L. Crantz in early spring, seeds must be stratified.

In some studies that was carried out on germination of seeds belonging to different types of rowans, seeds were said to need 5 - 6 months stratification and 10-15°C for germination (Saatçioğlu, 1971; Taylor and Gerrie, 1987; Gültekin et al., 2007). In another study, it was shown that obtaining enough sapling is impossible without stratification for plantings done in autumn, otherwise seeds need 3 months stratification (Gezer et al., 2005). The best germination was observered in Trabzon origin seeds that were taken for stratification for 4 months and were planted in an environment of 80% peat + 20% stream sand. When the percentage of germination of seeds were carefully examined, it was seen that weight of 1000 grains of the seed and its diameter had quite a lot of effects on germiantion. In the study on *S. domestica* L. carried out by Miko and Gazo (2004), it was emphasized that there is a negative relationship between weight of 1000 grains and germination. Furthermore, it was found that the higher the quality of *S. torminalis* L. Crantz seed, the higher the ratio of its germination. Takos (2003) obtained a result of 1% by planting *S. torminalis* L. Crantz seeds in autumn, without applying any process. The result is parallel to autumn plantation done in this study. This is caused by seed having an embryo that is inactive

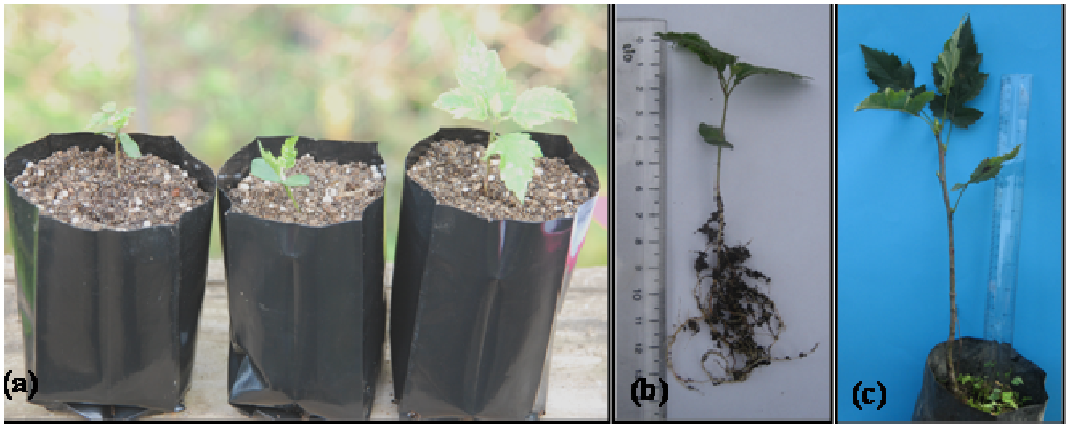

Figure 5. Several views from germinated seeds; (a, b) 4 months old seedling, (c) 2 years old seedling.

and has a scutcheon. This further show the need for pretreatment before plantation.

The production of wild service tree (*S. torminalis* L. Crantz) with a ratio of 96.6% is an important achievement. This type of production that is used only in forested areas and in the rural landscape in Turkey, will come into prominence in landscape architecture and is provided to be used much more in parks and gardens.

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