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Effects of Different Treatments on Seed Germination of Some Service Tree Genotypes (Sorbus domestica L.) Grown in Tokat Region

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ABSTRACT: The research was carried out between 2009-2010 to determine the germination characteristics of the seeds of two service tree (Sorbus domestica L.) genotypes selected from the central district of Tokat province. 9 different treatments were applied to the seeds and germination characteristics were determined at different stratification times. Germination characteristics varied depending on genotype, stratification times, and treatments. While the best germination in 60D2 genotype was obtained by 80% in 105th day of the stratification with 2000 ppm GA3 treatment, the best germination in 60D3 genotype was obtained by 90% again in 105th day of the stratification with Vitamin C + 1000 ppm GA3 treatment. Moreover, rotting of the seeds was mostly seen in acid treatment. The seeds belonging to genotypes generally germinated in the first 5 days.

Keywords *– Service tree, Germination, Stratification, GA3, Vitamin-C*

1. Introduction

Different service tree species according to regions are found in Turkey. Service tree (S. domestica) is more common in the Marmara Region, Central and Western Black Sea Region, and in the north of Central Anatolian Region. Besides this, it is also found in Inner Aegean Region, Lakes Region and Hatay Region (Gültekin and Alan, 2007). Cultivation of service tree is not done in orchards. Moreover, consumption of this species is common especially in the cities in transition zones (Tokat, Amasya, Kastamonu, etc.).Service tree that belongs to Rosaceae family is a winter-deciduous and 17 taxa of it are naturally found in Turkey. The most important ones are Service tree (Sorbus domestica L.), wild service tree (S. torminalis), rowan or mountain ash (S. aucuparia), and S. umbellata.

Fruits of the service tree are an important source of nutrition for wildlife and people. S. domestica species are grown for fruit production. Besides, it is an important plant of landscape arrangements and urban afforestation with its different characteristics. There is not any statistical data in FAO or DIE database in terms of service tree production amount. It is also known as sorb apple in Germany. Fruits are consumed with pleasure and have healing properties for many diseases. It is beneficial if people with liver disease and diabetics consume juice and marmalade without sugar. In the past, sorbitol was used to obtained from fruits of service tree for diabetics. Marmalade of it is also good for spring fatigue and winter diseases. Furthermore, It is an industrial product made for compote, jam and tea. (Schönfelder and Schönfelder, 1982; Recht and Wetterwald, 1985).

Generally, medicinal properties and botanical studies weigh even more, and studies to determine cultivation and seed germination abilities are few. Although there is no common

propagation type for plant production, it is generally stated that it is propagated by grafting. Service tree seedlings used as the rootstock is usually obtained from the seeds of the service tree species in the area where it grows.

The study was conducted with the purpose of determination of germination characteristics of service tree, which is consumed with pleasure and known as a healing source. The results are important in terms of determination of germination characteristics and obtaining seedlings from the seeds for using as a rootstock in Tokat region.

2. Material and Methods

The material of the research that was the seeds of two service tree genotypes (60D2 and 60D3) selected from *Sorbus domestica L.* (True service tree), which consumed as a fruit, grown in Tokat (Gerçekcioğlu et al., 1997). The seeds extracted from the fruits harvested during maturation period, seed dried in the shade and sprayed with a 3% dose of a fungicide with an effective ingredient of 50% Captan to prevent infections (Büyükyılmaz et al., 1992).

2.1. Seed viability

The viability of the seeds of each genotype was determined by the TTC test. For Tetrazolium test; In 1% TTC (2, 3, 5-Triphenyl tetrazolium chloride) solution, the embryos were kept for 18-20 hours at 22-24 ° C laboratory conditions and the degree of staining was observed. The painted ones are recorded as live, the unpainted ones are recorded as inanimate (Özçağıran, 1975).

2.2. Seed treatments

In order to determine the germination abilities, the following treatments were made. Gibberellic acid treatments, hot water treatment, and acid scarification treatments were made according to (Carrera et al., 1988), (Özvardar and Özçağıran., 1991), (Gerçekçioğlu and Çekiç.,1999), bleach treatment and vitamin C treatments were made according to (Misra and Verma.,1980), Anonymous (1990-1991), Riley (1997).

Control: The seeds, which were kept in distilled water for 24 hours, were taken into the prepared stratification medium.

Gibberellic acid + Vitamin C treatments:
2000 ppm GA3 treatment,
Vitamin-C + 1000 ppm GA_3 treatment,
Vitamin-C + 2000 ppm GA_3 treatment,
Vitamin-C + 3000 ppm GA_3 treatment.
Vitamin C treatment at 100 ppm (Misra and Verma, 1980);
Vitamin C + Gibberellic acid treatment was applied at the same doses for 24 hours.

Hot water treatment: The seeds were kept in 70-100 oC hot water bath for 5 minutes, after that tap water was added until the temperature of the water drops to 40 oC, and without adding any water they were kept for two hours in the water whose temperature gradually decreases.

Bleach (Sodium hypochlorite) treatment: The seeds were kept in a 15% sodium hypochlorite for 18 hours and were taken into the stratification medium (Anonymous, 1990-1991).

Acid (sulphuric acid) scarification treatment: H_2SO_4 was added in service tree seeds in petri dishes twice as much as the weight of the seed and kept for 5 minutes, then washed in flowing water until the sticky substances were gone and then taken into the stratification medium.

Stratification in the field: Seeds were taken to the open field directly for stratification in perlite + sheep manure + silt (1:1:1) compost.

2.3. Scarification

The treated seeds were placed in 1 kg plastic containers and were mixed with moist Sterile agricultural perlite and left to stratify under refrigerator conditions (7.11 ± 1.17 oC). Humidity (98±2.16%) in the container was protected by wetting when necessary.
In these conditions, stratification was planned as 6 months, however, after 135th day of stratification, the experiment was stopped. No samples were taken for two months. After two months, the seeds were taken from the stratification medium to the germination medium every 15 days (on the 60th, 75th, 90th, 105th, 120th, 135th day of the stratification).

2.4. Germination

Germination characteristics were observed in 10 seeds in each repetition (3 repetitions). For this purpose, germination was done in sterile petri dishes with drying paper placed and moistened under laboratory conditions with a temperature of 23.2±3.67 °C. Germination characteristics of seeds taken from the stratification medium were observed for 14 days during the specified periods.

2.5. Observations

Cracking rate (%) of the seeds that were taken to the germination medium on 5th, 8th, 12th, and 14th days, germination rate (%), germination ability, and coefficient of the speed of germination were determined.

The germination rate coefficient was determined according to the formula below. This coefficient showed which days the seeds germinated more in the 14-day germination environment.

Germination Rate Coefficient: Sum of germinated seeds X 100 / A1T1 + A2T2 + …. AnTn
T: 5,8, 12th and 14th days kept in germination environment for 14 days and sampled during this period.
A: Number of seeds germinated in T.

The results of the experiment were evaluated according to the randomized plots. After making variance analysis, the difference between means was compared according to the LSD (Düzgüneş et al., 1983). Variance analysis was made in stratification times and treatments where germination in genotypes is the best.

3. Results and Discussion

According to the results of the Tetrazolium test (TTC) conducted to determine the viability rates of seeds, the viability rates of both genotypes were determined as 100%. The results of the seeds of service tree genotypes '60D2' and '60D3' placed in the stratification medium after

the treatments, depending on the stratification times and treatments are given in Table 1 and Table 2.

Table 1. Stratification times for '60D2' service tree genotype, and germination (germ) and rotting (rot) rates by treatments*

Treatment	60th day of stratification		75th day of stratification		90th day of stratification		105th day of stratification		120th day of stratification		135th day of stratification	
	Germ (%)	Rot. (%)	Germ. (%)	Rot. (%)	Germ. (%)	Rot.(%)	Germ. (%)	Rot. (%)	Germ (%)	Rot. (%)	Germ (%)	Rot. (%)
Control	3,33	6,67	-	-	76,67	-	53,33	3,33	80,00	13,34	-	-
Acid	3,33	70,00	-	86,67	3,33	63,34	66,67	16,67	-	-	-	-
Bleach	3,33	-	3,33	3,33	36,67	-	70,00	-	76,67	16,67	-	-
Vit-C+1000 ppm GA_3	10	6,67	16,67	-	63,33	-	73,33	-	-	-	-	-
C-vit+2000 ppm GA_3	6,67	-	40,00	-	63,33	-	56,67	20,00	-	-	-	-
Vit-C +3000 ppm GA_3	-	-	-	3,33	66,63	-	70,00	3,33	-	-	-	-
2000ppm GA_3	3,33	-	6,67	-	70,00	-	80,00	6,67	-	-	-	-
Hot water	-	10,00	-	36,67	-	30,00	3,33	6,67	6,67	33,34	16,67	40,00
Stratification in the field	-	-	6,67	10,00	6,67	10,00	6,67	-	-	-	-	-
*: Germ: Germination rate, Rot: Rotting rate												

Stratification time was planned as 180 days, however, the experiment was terminated due to large decreases after 120th day in '60D2' genotype and after 135th day in '60D3' genotype. However, the results of both genotypes were followed for 180 days to determine the result of hot water treatment, but no germination was detected in the seeds during this process. Moreover, the best germination for '60D2' genotype was observed in 90th and 105th days of the stratification, the best result was obtained in 105th day of stratification with 2000 ppm GA3 treatment. Seed rotting for this genotype was intensively observed generally in acid treatment in every stage of stratification. In other treatments, it was determined in lower levels (Table 1).

Table 2. Stratification times for '60D3' service tree genotype, and germination (germ) and rotting (rot) rates by treatments*

Treatment	60th day of stratification		75th day of stratification		90th day of stratification		105th day of stratification		120th day of stratification		135th day of stratification	
	Germ (%)	Rot. (%)	Germ. (%)	Rot. (%)	Germ. (%)	Rot. (%)	Germ. (%)	Rot. (%)	Germ (%)	Rot. (%)	Germ (%)	Rot. (%)
Control	-	-	3,33	10,00	50,00	-	83,33	6,67	-	-	-	-
Acid	6,67	10,00	10,00	16,67	33,33	-	3,33	30,00	-	-	-	-
Bleach	-	-	3,33	-	30,00	-	73,33	-	-	-	-	-
Vit-C+1000 ppm GA_3	3,33	3,33	33,33	-	86,67	6,67	90	-	-	-	-	-
Vit-C +2000 ppm GA_3	13,33	13,33	26,67	-	83,33	-	76,67	-	-	-	-	-
Vit-C +3000 ppm GA_3	3,33	6,67	23,33	-	73,33	3,33	90	-	-	-	-	-
2000ppm GA_3	13,33	13,33	26,67	-	83,33	-	76,67	-	-	-	-	-
Hot water	-	13,33	-	33,33	-	10,00	6,67	-	-	43,33	10,00	30,00
Stratification in the field	-	-	3,33	3,33	13,33	-	13,33	-	-	-	-	-
*: Germ: Germination rate, Rot: Rotting rate												

In 60D3 type, cracking observed on the 60th day of folding in vitamin C + 2000 ppm GA3 and 2000 ppm GA3 applications. The highest germination rate for '60D3' genotype was determined again in 90th and 105th days of the stratification (Table 2).

Germination rates in 60th days were quite low, and germination started after 75th day Table 1,2). According to some studies, seeds kept at 0-5 0C for stratification for 60 days or more, can be germinated by planting in moist and permeable germination medium (sand, soil, perlite, etc.) or directly on the field (Anonymous, 2007b). Pipinis et all. (2015) reported, non-stratified and 1-month stratified seeds of S. domestica and S. torminalis, regardless of GA3 treatment, exhibited very low germination or failed to germinate. But, Gultekin et al. (2007) reported a 45-day period of cold stratification is sufficient to break dormancy in fresh seeds of S. domestica and S. torminalis.

Table 3. Germination rates of '60D2' and '60D3' genotypes in 90th day of stratification (%)

Treatment	**60D2**	**60D3**	Mean
Control	76,67 a	50,00 bc	63,33 a
Sulphuric acid	3,33 c	33,33 cd	18,33 bc
Bleach	36,67 ab	30,00 cd	33,33 b
Vit. C + 1000 ppm GA_3	63,33 a	86,67 a	75,00 a
Vit. C + 2000 ppm GA_3	63,33 a	83,33 a	73,33 a
Vit. C + 3000 ppm GA_3	66,63 a	73,33 a	70,00 a
2000 ppm GA3	70,00 a	83,33 a	76,66 a
Hot water	0,10 c	0,10 e	0,10 c
Stratification in the field	6,67 c	13,33 de	10,00 c
Means	42,62	48,53	-

+: Treatments** ; Genotypes: NS; (Treatment x genotype)* NS : Not significant

$^{+}$: Difference between means indicated by different letters
*Significant at a level of (5%) and **(1%) NS: Not significant

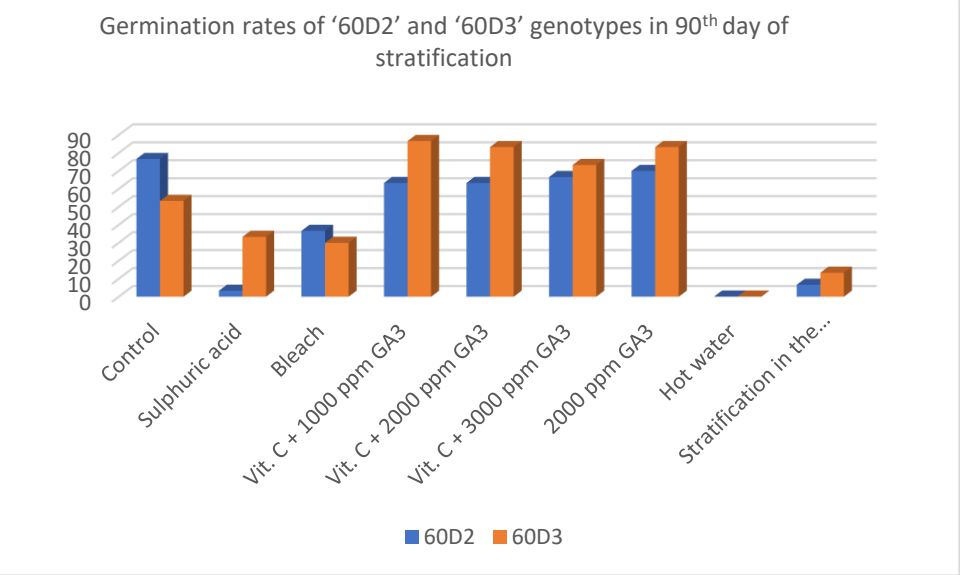

Fig. 1. Germination rates of '60D2' and '60D3' genotypes in 90th day of stratification

While the best germination rate for '60D3' genotype on 90th day of stratification was obtained with 86,67% from *Vitamin-C + 1000 ppm GA_3* treatment, the best germination rate for '60D2' genotype in all treatments in same stratificaton time was obtained same with the control treatment as 76,67%. Furthermore, the results of the control treatment were determined as very irregular. In particular, it is thought that this situation may be due to the inability to complete internal dormancy. Seeds of most Sorbus species, have only a dormant embryo which complicates germination (Pipinis et all. 2015). Rotting rates in sulphuric acid treatment in 90th and 105th days were observed as the highest both genotypes. However, the sensitivity rates of the genotypes showed a difference. The excess rotting in acid treatments may have been due to the longer duration according to the stone fruits (Gerçekçioğlu and Çekiç, 1999). Additionally, it was determined that 90% of the seeds germinated in the first 5th days while 10% of them germinated between 5th and 8th days for both genotypes.

Table 4. Germination rates of '60D2' and '60D3' genotypes in 105th day of stratification (%)

Treatment	Service tree genotypes		Mean
	60 D 2	60 D 3	
Control	53,33 b	83,33 a	68,33 ab
Sulphuric acid	66,67 ab	3,33 b	35,00 c
Bleach	70,00 ab	73,33 a	71,67 ab
Vit. C + 1000 ppm GA_3	73,33 ab	90,00 a	81,67 ab
Vit. C + 2000 ppm GA_3	56,67 b	76,67 a	66,67 b
Vit. C + 3000 ppm GA_3	70,00 ab	90,00 a	80,00 ab
2000 ppm GA3	80,00 a	76,67 a	78,33 a
Hot water	3,33 c	6,67 b	5,00 d
Stratification in the field	6,67 c	13,33 b	10,00 d
Means	53,34	58,15	-

+ :Treatments**; Genotypes: NS;

+: Difference between means indicated by different letters
*Significant at a level of (5%) and **(1%) NT: Not significant

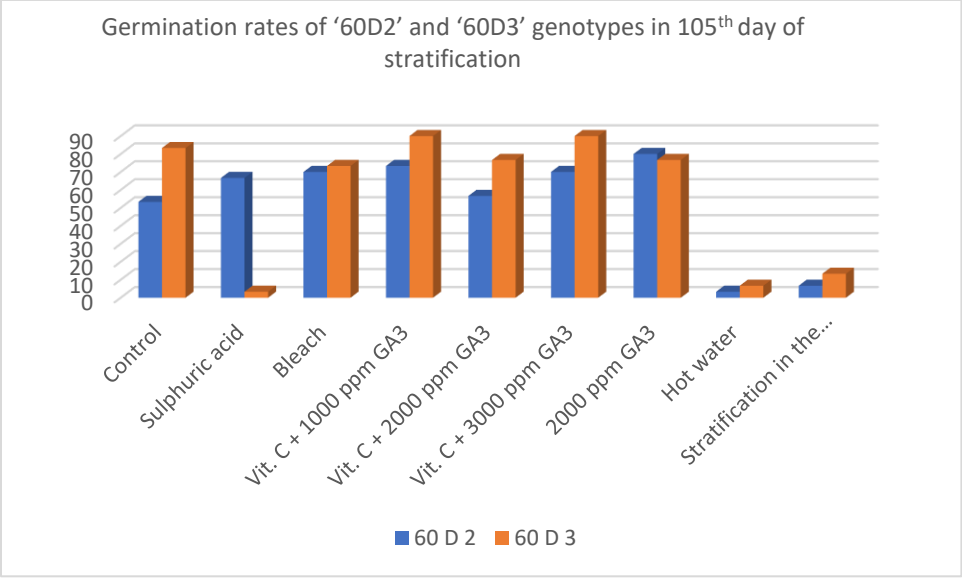

Fig. 2. Germination rates of '60D2' and '60D3' genotypes in 105th day of stratification

While the best germination rate for '60D3' genotype on 105th day of stratification was obtained with 90,00% from *Vitamin-C + 1000 ppm* GA_3 and *Vitamin-C + 3000 ppm* GA_3 treatments, the best germination rate for '60D2' genotype in same stratification time was obtained with 80,00% from 2*000 ppm* GA_3 treatment. As Hartmann and Kester (1997) stated that germination can also be prevented in some cases for internal reasons, even if all environmental conditions are appropriate.

In the results of the present study, *the acid treatment* that was done for physical scarification, *bleach treatment*, and *hot water treatment* did not give good results. In the sowing seeds directly to the field, germination was determined in both genotypes at the 75th, 90th, and 105th days of stratification, even at a low rate of 3.33-13.33%. Furthermore, no germination was observed during further stratification times. The results in the present study were found to be quite high when they are compared with the results of other studies even they are limited.

Although it is initially thought that there will be no difference between the genotypes, *it is also important to find different germination rates according to the genotypes*. While the results of Şenay (2007) of germination characteristics of the seeds of *S. domestica* species (89,00%) have been similar to our findings, the results as 9,00-17,50% of the studies by Yagihashi et al. (1998), Koçak (2006), and Anonymous (2007a) have been quite lower than our findings. Additionally, stratification times have been generally similar.

4. Conclusion

As a conclusion, germination rates can vary according to genotypes even if they are of the same type. Besides, stratification times and applications are also effective. According to the results the best germination rate for '60D2' genotype was determined in 105th day of stratification with 2000 ppm GA_3 treatment, while the best germination rate was observed for '60D3' genotype in 105th day of stratification with Vitamin C + 1000 ppm GA_3 treatment recommended. Moreover, the results for both genotypes were not successful in bleach treatments, which were examined as different treatment. For longer periods of stratification of 60D3 genotype, only the Gibberellic acid application is recommended.

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