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The Replication of the Purple-flowered Rhododendron (*Rhododendron ponticum* L.) by Seed and Chances of Survival in Replanting in Different Media

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Abstract: This study investigates the germination, replanting and survival of *Rhododendron ponticum*, a species native to Turkey, in different media. The conditions of the germination medium were first investigated and the seedlings obtained were applied as a first replicate in a peat medium, and at the end of 4 months a second replicate in 7 different media was used to examine their development and survival in these media. The data obtained were then compared to the data obtained from soil analysis and their relations were outlined along with statistical considerations. According to the findings, an efficient germination was observed when the seeds were sown in the form of a thin layer. By administering water via a handspring to maintain the moisture of the soil at an adequate level and preventing the seeds from aggregating during watering resulted in a homogeneous germination. The appropriateness of the peat soil in the first replanting of the rhododendron seedlings reproduced from seeds was determined (based on the healthy development of the seedlings). The *Rhododendron ponticum* L. seedlings in the second replanting adapts better in soils that are acidic (pH 4.5-5.5) and rich in organic matter (60%-70%) and in moisture (60%-70%) and semi-shaded areas (areas that receive 50% or more of solar radiation indirectly).

Key Words: *Rhododendron, Rhododendron ponticum L., replicate by seed*

Mor Çiçekli Ormangülü (*Rhododendron ponticum* L.)'nün Tohumla Üretimi ve Farklı Ortamlara Şaşırtılmasında Yaşama Başarıları

Özet: Türkiye'de Doğu Karadeniz Bölgesi'nin doğal türleri arasında yer alan *Rhododendron ponticum* L.'nin, tohumla üretimi ve ön adaptasyon çalışmalarında öncelikle çimlenme ortamı şartları araştırılmış, elde edilen fidecikler turba ortamda 1. şaşırtmaya, 4 ay sonunda 7 farklı ortamda 2. şaşırtmaya alınarak bu topraklardaki gelişme ve yaşama durumları incelenmiştir. Elde edilen verilerin toprak analizleri sonucundaki karşılıklı ilişkileri istatistik sonuçlarıyla ortaya konmuştur. Bu çalışmada elde edilen bulgulara göre; tohumların ince bir tabaka şeklinde ekilmesiyle etkili bir çimlenme görülmüştür. Sulamanın el springi ile yapılarak toprak neminin muhafaza edilmesiyle tohumların sulama sırasında bir araya toplanması önlenmiş ve sonuç olarak homojen bir çimlenme gözlenmiştir. Tohumdan üretilen ormangülü fideciklerinin birinci şaşırtmada turba toprağın uygun olduğu (fideciklerin sağlıklı gelişimleri göz önüne alınarak) belirlenmiştir. İkinci şaşırtmaya alınan *Rhododendron ponticum* L. fidanlarının, pH bakımından asidik (pH 4.5-5.5), organik maddece zengin (% 60-70) topraklarda, yarı gölge (güneş ışığının %50'sini veya daha fazlasını dolaylı olarak alan) ve nemli alanlarda (%60-80) daha iyi adapte olabildiği bulunmuştur.

Anahtar Sözcükler: Ormangülü, *Rhododendron ponticum* L., tohumla üretim.

Introduction

Rhododendrons are included in the genus *Rhododendron* of shrubs in the family *Ericaceae* of the seed plants super-division of the plant kingdom. They are deciduous or evergreen bushes, or occasionally ligneous plants in the form of trees. They have evergreen, leathery, entire-sided, and wide striped or elepidote leaves (Abbot, 1972; Ansin and Terzioglu, 1994).

Rhododendron ponticum L., growing naturally in Turkey, is a decorative ornamental plant due to its flowers and leaves. Although the purple-flowered rhododendron (*Rhododendron ponticum*) is mainly spread over the UK, Ireland, Bulgaria, Turkey, Caucasus, and Lebanon, and some areas in south-east Spain, central and southern parts of Portugal as well as Belgium and France. Among these areas, the plant is mostly spread

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over the UK, Ireland, and the Black Sea region in the north of Turkey (Robinson, 1980; Clay et al., 1992; Colak and Aksoy, 1997).

It exists along the entire Black Sea coast of Turkey to Zonguldak, Bolu, Duzce, Bilecik, Demirkoy, and the Istranca Mountains in the west. It is most heavily distributed on the north-west Anatolian Mountains (Ansin and Terzioglu, 1994).

The plant likes shady areas and even soils with high moisture content (Küçük and Topçu, 1993). It generally prefers cool and protected northerly mountainsides and riverbeds (where high illumination, wind, and draught are not predominant factors) (Thomson et al., 1993; Libb and Nilsen, 1997; Esen, 2000). In addition, *Rhododendron ponticum* does not prefer soils with low moisture content (Cross, 1981; Colak and Aksoy, 1997).

Although Rhododendron groups are considered harmful in terms of forestry as they block the development of the primary tree distribution within forest populations. There are, therefore efforts to eliminate them via mechanical and chemical means. They can be also utilised aesthetically as well as functionally in landscape planning. In addition, they can be used in road level stabilisation, particularly in traffic island planting to create stimulating effects thanks to their colourisations and flower colours (Clarke, 1982; Reiley, 1995).

Rhododendrons cover the soil surface partly or completely in the middle and lower parts of the highly steep and sloped forests or in areas without forest in Northern Anatolia. In this region, they exist as a live cover and protect the soil against erosion and landslides, and serve as a hiding and protection area for many animals (Küçük and Var, 1995).

Due to its characteristics outlined above, *Rhododendron* is one of the most important plants in landscape architecture. However, this plant has remained only in the countryside landscapes of Turkey and has not been brought into the urban landscape. Our main objectives in this study include the identification of the conditions for the adaptation of *Rhododendron ponticum* L. to increase its widespread use in urban landscape planning and lead the way to ensure that other rhododendron taxa in Turkey are utilised.

Materials and Methods

Materials

Rhododendron ponticum seeds were collected at Çamburnu in the Surmene Sub-province of Trabzon Province at 300-500 m asl. The replanting soil used for the seedlings consisted of peat (pH 4.91, organic matter 70.3%), perlite + peat (pH 4.96, organic matter 63.5%), sand + 5-year waste tea leaves (pH 6.56, organic matter 17.6%), sand + 2-year waste tea leaves (pH 6.65, organic matter 20.4%), sand + forest soil (pH 5.58, organic matter 11.3%), sand + peat (pH 6.70, organic matter 18.3%), loamy sand + peat (pH 6.38, organic matter 16.0%).

The light intensity was measured with MX4 brand luxmeter and a thermohydrograph was used to measure air temperature and humidity.

Methods

Preparation of Germination and Replanting Media

In order to prepare the germination medium for *Rhododendron ponticum* seeds, wood boxes were filled with forest soil, and drainage was ensured. A special thinly sifted seed sowing turf (Substrate I) was laid on this soil to have a thickness of 3 cm.

For the first replanting of the seedlings obtained from seeds, polyurethane boxes were filled with peat soil, in the light of the data obtained from the results of previous studies. This medium was used for the first replanting.

In order to find out the survival rates of the seedlings obtained from the seeds in different media, 7 different media were prepared in the second replanting to identify interactions with other soil characteristics such as the effect of the pH on seedling growth and the solubility of the chemicals in the soil. The 7 media given below were put in polyethylene bottles and the second replanting process took place within this structure:

1- Pure peat medium; 2- 20% Perlite + 80% Peat; 3- 20% Sand + 80% (5-year) waste tea leaves medium; 4- 20% Sand + 80% (2-year) waste tea leaves medium; 5- 20% Sand + 80% Forest Soil medium; 6- 20% Sand + 80% Peat medium; and 7- 20% Loamy Sand + 80% Peat medium.

Organic matter was quantitated according to a modified Walkley-Black wet oxidation method (Jackson, 1962). The pH measurements were performed with a pH-meter with glass electrode in the soil-water mixtures (1:2.5) (Gulcur, 1974).

Seed Planting and Replanting

After the Rhododendron seeds had been collected from the field, they were laid out away from direct sunlight in the greenhouse environment until the seed capsules opened and the seeds became visible. The thousand-piece-weight of rhododendron seeds was 0.0081 g. When the seeds were out, they were sown as a thin layer in the media prepared in the boxes. The boxes were covered with glass (4 mm) to keep moisture in and the seeds were left for germination in the semi-shaded environment of the greenhouse. Soil moisture was checked with a portable moisture meter and water was administered to keep the moisture level at 30%-40% by wetting the soil surface or the glass cover as required by a handspring. When the germination started, the cover was gradually opened every day (by opening it 1 cm each day for 10 days). When 3-4 leaves formed on the seedlings, the glass cover was completely removed.

When the seedlings formed in the boxes had 6-7 leaves, they were taken to the first replanting in the peat soil in polyurethane boxes. A total of 210 *Rhododendron* seedlings produced by the first replanting were planted in 7 different soils prepared for the second replanting in polyethylene bags in 3 rows, with 10 bags of 18 x 20 cm in diameter in each row, to make a total of 30 bags (for each medium). The seedlings were watered periodically once a day. Twenty days after the second replanting, seedlings were removed and kept under the shade of a coverage material in the outer environment and watered as required based on the moisture level of the soil. Starting from the 15^{th} day, the coverage material was uncovered for half an hour between 4:00 pm and 4:30 pm. Following this date, the cloth shade was uncovered 15 min earlier every 3 days and left open until 4:30 pm. The cloth shade was completely removed after 2 months.

Results

After the seeds were sown in the germination medium, the semi-shaded environment and soil moisture requirement for germination were provided, and it was observed that both plant seeds germinated after 4 weeks.

The seedlings obtained were administered as a first replanting in polyurethane boxes. Sixty-seven percent of the plants in the first replanting survived.

In the second replanting process carried out to investigate the effect of soil characteristics on the adaptation of the seedlings, it was observed that the seedlings in 7 different growing environments had different growth and survival rates. One month after replanting, seedling mortalities were observed. According to the observations carried out 2 months after the replanting, there was no significant difference in the seedling survival rates as compared to the previous month. The seedling mortality rate was found to be 10% in the first month. At the end of 2 months, it was observed that 2% of the surviving seedlings had died.

Light intensity measurements under the cloth shade revealed that the intensity of the light under the shade was 17%-25% of that in the outer environment.

The survival rates, the number of root suckers and developmental conditions of the seedlings according to the last measurements obtained at the end of the vegetation season are given in Table 1. The values in Table 1 were evaluated via analysis of variance and Duncan's test as well as graphics. Accordingly, the height and diameter growth and survival rates of the *Rhododendron ponticum* seedlings in different soils were found to be different.

The results of the analysis of variance showed that there were very significant differences among the groups in terms of height and diameter growth in different soil types (Table 2).

Duncan's test was used to rank the soils used according to the developmental condition of the seedlings (Table 3). Accordingly, the maximum diameter developments were obtained in the "20% perlite + 80% peat soil mixture" and height development in the "20% sand + 80% 2-year waste tea leaves mixture". The minimum diameter and height development was detected in the "20% sand + 80% forest soil mixture". The environment with the highest level of survival for the *Rhododendron ponticum* seedlings was the peat and "20% perlite + 80% peat soil mixture", whereas the lowest survival level was in the "20% sand + 80% peat soil mixture" (Figure 1).

The amounts of clay, sand and dust were measured by a mechanical analysis of the soils used. All soils were found to be of sandy loam origin.

The chemical analyses of the soils showed that all the soils used were rich in organic matter. The amount of soil

Table 1. Survival rates and developmental conditions of *Rhododendron ponticum* seedlings

Secondary Replanting Media	Survival Rate	Average Number of Root Suckers per Seedling	Average Root Neck Diameter (cm)	Average Height (cm)
Peat	83	3.2 ± 0.1	0.30 ± 0.13	7.12 ± 3.46
20% perlite + 80% peat	93	2.8 ± 0.1	0.36 ± 0.11	6.54 ± 1.98
20% sand + 80% 5-year waste tea leaves	77	1.0 ± 0.1	0.34 ± 0.14	9.17 ± 3.73
20% sand + 80% 2-year waste tea leaves	73	1.5 ± 0.1	0.34 ± 0.14	8.91 ± 3.37
20% sand + 80% forest top	73	0.5 ± 0.1	0.23 ± 0.11	5.09 ± 2.91
20% sand + 80% peat	70	1.0 ± 0.1	0.30 ± 0.08	5.67 ± 1.92
20% loamy sand + 80% peat	80	2.5 ± 0.1	0.33 ± 0.09	6.50 ± 1.95

Table 2. Analysis of variance for *Rhododendron ponticum* seedlings according to length-diameter development in different growing media.

Examined Characteristic	Variation Source	Total Squares	S. D.	Mean Squares	F-Rate	Significance
Rh. ponticum diameter	Among Groups	0.567	7	8.10E-02	5.119	0
	In-groups	2.848	180	1.58E-02		
	Total	3.415	187			
Rh. ponticum height	Among Groups	273.539	7	39.077	4.464	0
	In-groups	1575.583	180	8.753		
	Total	1849.122	187			

Table 3. Duncan's test yielding soil rankings according to the length-diameter developments of the *Rhododendron ponticum* seedlings in different growing media.

Duncan's Test for Diameter Development					Duncan's Test for Height Development				
Soil Type	Number of Subjects	1	2	3	Soil Type	Number of Subjects	1	2	3
5	29	0.175			5	29	3.862		
1	30		0.250		6	22	5.409	5.409	
3	28		0.282		1	30		5.933	5.933
4	26		0.284		7	25		6.240	6.240
6	22		0.290	0.290	2	28		6.535	6.535
7	25		0.320	0.320	3	28			7.535
2	28			0.360	4	26			7.538
Significance		1.000	0.069	0.054	Significance		0.056	0.208	0.077

organic matter varied between 21% and 93%. This ratio was between 30%-33% in the "20% sand + 80% 2-year waste tea leaves", where the height and diameter increase of the seedlings was maximum, whereas this ratio was 80% in the "20% perlite + 80% peat soil mixtures", where the survival rates were maximum. In the natural growing environment, this ratio was between 11% and 15%.

The results of the soil pH analysis showed that, of the media used, peat and "20% perlite + 80% peat soil

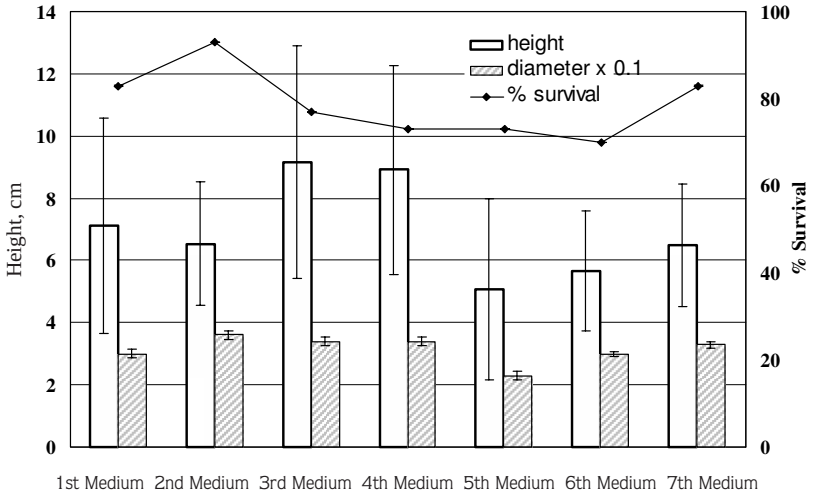

Figure 1. The comparison of height-diameter development and survival rates of *Rhododendron ponticum* seedlings in different growing media (1st Medium: Pure peat, 2nd Medium: 20% Perlite + 80% Peat, 3rd Medium: 20% Sand + 80% (5-year) waste tea leaves, 4th Medium: 20% Sand + 80% (2-year) waste tea leaves, 5th Medium: 20% Sand + 80% Forest Soil, 6th Medium: 20% Sand + 80% Peat, 7th Medium: 20% Loamy Sand + 80% Peat).

mixture" was strongly acidic (4 < pH < 5), "20% sand + 80% forest soil" and "50% peat + 50% 5-year waste tea leaves" soil mixture was moderately acidic (5 < pH < 6), and "20% sand + 80% 2-year waste tea leaves", "20% sand + 80% peat" and "20% loamy sand + 80% peat" soil mixtures were weakly acidic (6 < pH < 7). The soil of the natural growing environment was found to be strongly acidic.

It was found that the length-diameter development of the seedlings was high in weakly acidic soils, whereas the survival rates were high in strongly acidic soils (Figures 2 and 3).

In environments where the height-diameter development is high, it was observed that this development had a non-homogeneous distribution for seedlings in the same type of soil (Figure 4). In addition, seedling deaths were increased towards the end of the vegetation season. In strongly acidic soils, where the survival rate was high, the length-diameter development was homogeneous.

Correlation analysis was used to evaluate the soil analysis results (Table 4). The relationship between survival rate and soil pH was important at a significance level of 0.046. The survival rate and pH were reverse-proportional. The relation between the survival rate and the organic matter content of the soil was important with a significance level of 0.019. The survival rate and organic matter were proportional. Furthermore, the relation between the pH and the organic matter was also quite important with a significance level of 0.008 and this relation was reverse-proportional. While the ratios of clay, dust and sand were significant between themselves, their relation to the survival rate was insignificant.

Discussion

In a study on the replication of Rhododendron by seed, Cox (1990) stated that sowing the seeds as a thin layer and protecting their moisture are the golden rules of replication by seeds. According to the findings of this study carried out to find the effects of some ecological factors in the replication of forest roses by seeds and their pre-adaptation, an efficient germination was observed by sowing the seeds in a thin layer. By administrating water via a handspring to protect the moisture of the soil and to prevent the seeds from aggregating during watering, a homogeneous germination was observed. The appropriateness of the peat soil in the first replanting of the Rhododendron seedlings reproduced from seeds was determined (based on the healthy development of the seedlings)

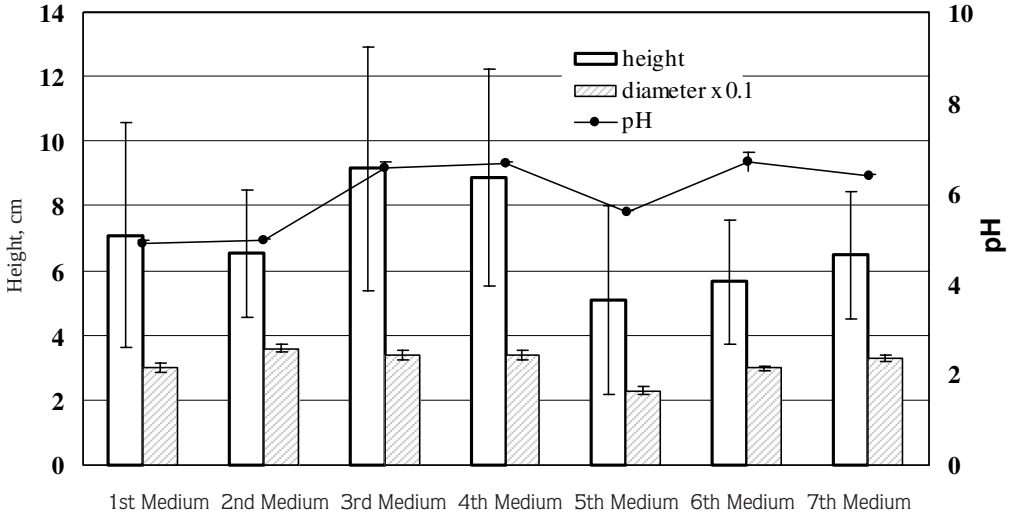

Figure 2. Height growth of *Rhododendron ponticum* in relation to pH and different growing media (1st Medium: Pure peat, 2nd Medium: 20% Perlite + 80% Peat, 3rd Medium: 20% Sand + 80% (5-year) waste tea leaves, 4th Medium: 20% Sand + 80% (2-year) waste tea leaves, 5th Medium: 20% Sand + 80% Forest Soil, 6th Medium: 20% Sand + 80% Peat, 7th Medium: 20% Loamy Sand + 80% Peat).

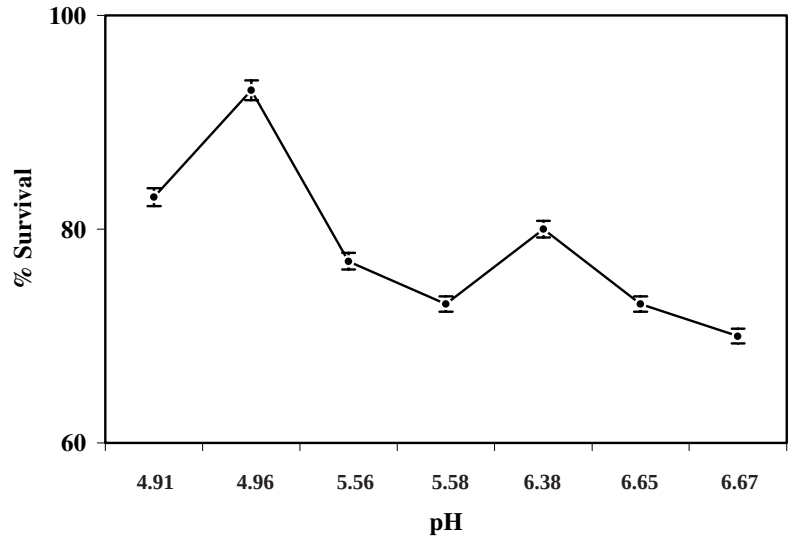

Figure 3. Survival rates of *Rhododendron ponticum* in relation to pH.

When the Rhododendron seedlings in the second replanting were placed in the outer environment and kept under the cloth shade for a while, no sun damage was observed on the leaves even at times when the light intensity was high. Similarly, the gradual removal of the cloth cover was observed to be useful in adaptation to the outer environment. Cox (1990) stated that young Rhododendron sprouts were quite sensitive to direct sunlight, and thus needed quite shaded areas.

In the second replanting, the diameter and height development of the seedlings were maximum in "20% sand + 80% 5-year waste tea leaves" and "20% sand + 80% 2-year waste tea leaves", of which pH values were higher as compared to the other soils. However, it was

Figure 4. Height development of *Rhododendron ponticum* plants growing in the same level pH (pH ≥ 6) soil (the height-diameter development is high on the right, and is low on the left).

observed that the developments in these 2 soils and other high-pH soils were not homogeneous. In addition, although there was a rapid development in high-pH soils, the deaths increased towards the end of the vegetation season. In low-pH soils, the length-diameter increase was lower but more homogeneous as compared to the other ones. Again, the survival rate in the latter was much higher as compared to the others. Reiley (1995) states that Rhododendrons are best raised in environments where the soil pH is between 4.5 and 5.5.

According to Clarke (1982) and Brenzel (1997), forest roses prefer soils that are rich in organic matter. Accordingly, many Rhododendron species prefer high mountainous areas rich in organic matter as their natural habitat. Our study revealed parallel results showing that survival rates were proportional to the organic matter contents. Particularly, soils with low-pH values and high organic matter content produced the best results. This is attributed to dissolving of soil minerals required by forest roses at pH ratios between 4.5 and 5.5 (Reiley, 1995).

Table 4. Correlation matrix showing the relation between survival rates and soil analysis.

		pH	Organic Material	% Clay	% Dust	% Sand	% Losses in Fire	% Survival
pH	Pearson Relation	1	-0.815*	0.065	-0.159	0.034	-0.848**	-0.835*
	Significance		0.014	0.879	0.707	0.937	0.008	0.046
	Number of Subjects	7	7	7	7	7	7	7
Organic Material	Pearson Relation	-0.815*	1	-0.33	-0.156	0.271	0.916**	0.793*
	Significance	0.014		0.425	0.712	0.516	0.001	0.033
	Number of Subjects	7	7	7	7	7	7	7
% Clay	Pearson Relation	0.065	-0.33	1	0.762*	-0.955**	-0.251	0.073
	Significance	0.879	0.425		0.028	0	0.548	0.876
	Number of Subjects	7	7	7	7	7	7	7
% Dust	Pearson Relation	-0.159	-0.156	0.762*	1	-0.919**	-0,105	-0.002
	Significance	0.707	0.712	0.028		0.001	0.804	0.996
	Number of Subjects	7	7	7	7	7	7	7
% Sand	Pearson Relation	0.034	0.271	-0.955**	-0.919**	1	0.201	-0.043
	Significance	0.937	0.516	0	0.001		0.634	0.927
	Number of Subjects	7	7	7	7	7	7	7
% Losses in Fire	Pearson Relation	-0.848**	0.916**	-0.251	-0.105	0.201	1	0.835*
	Significance	0.008	0.001	0.548	0.804	0.634		0.019
	Number of Subjects	7	7	7	7	7	7	7
% Survival	Pearson Relation	-0.835*	0.793*	0.073	-0.002	-0.043	0.835*	1
	Significance	0.046	0.033	0.876	0.996	0.927	0.019	
	Number of Subjects	7	7	7	7	7	7	7

* Meaningful with a significance level of 0.050
** Meaningful with a significance level of 0.010

In summary, the present study showed that *Rhododendron ponticum* adapts better in moist soils rich in organic matter and with pH values between 4.5 and 5.5. The semi-shaded areas with high humidity and mild climate are also very suitable for better adaptation of Rhododendron plants.

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