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RESEARCH ARTICLE

Growth Performances of *Photinia* × *fraseri* Dress. Seedlings from Cuttings of Five Ortets in Different Districts

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ABSTRACT

With its impressive leaves and ability to resist harsh environmental conditions, *Photinia* × *fraseri* Dress., a hybrid species, is widely used in landscaping and has an ever-increasing economic and environmental value. The economic value of the landscape plants is directly proportional to their growth performance. For this reason, it is of great importance to identify and use the fastest growing ortet, especially in landscape plants in terms of cost and profitability. In this study, five ortets of *P.* × *fraseri* were compared in terms of their growth performances based on seedling height, root collar diameter, leaf length, leaf width, root length, root number, last shoot length, stem and root fresh-dry weights, and seedling fresh and dry weights. As a result of the study, it was found that the growth performances of five ortets in different districts were generally ranked as Eregli < Alapli < Ulus < Devrek < Zonguldak, and that the difference between the pairs of ortets in terms of some seedling characters reached up to 2.8 times. The study suggests that the selection of ortet is extremely important in seedling growth.

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1. Introduction

The structural changes in economic, social, cultural, and political areas due to rapid development process going on around the world accelerated the urbanization process, and caused the destruction of green spaces (Ucun Ozel et al., 2019). Rapid urbanization and industrialization have alienated people from nature a little more each day and disrupted the harmony that should exist among them and environment they live in (Ayan et al., 2021; Başbayraktar & Yücedağ, 2023; Yücedağ & Aşik, 2023). Humans, a part of nature, carry a piece of nature everywhere they live in, sometimes a houseplant, sometimes a small garden and sometimes a carefully-arranged park. At this point, rather than their direct benefits, trees and shrubs also provide indirect benefits for aesthetic and recreational purposes in parks, gardens and landscaping areas, and these are of great significance for human health (Yücedağ & Aşik, 2023).

Plants are crucial to the design of landscape spaces for both aesthetic and practical reasons. This is because the plant materials are very rich and diverse living materials for decoration, building and place-making purposes with their moving, dynamic, ductile, decorative, aesthetic, economic and functional features (Gül et al., 2006). In the industrialized world, especially in developed cities, landscape designs have become an indispensable element of urban planning, and thus become a science. Each section of the landscape designs has been transformed into specialization-required areas, and the use

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of materials, especially plant elements, has diversified and improved (Guney et al., 2016).

The use of plant species, which are not naturally grown in a region, and thus are not common to be found in the natural flora, increases the value of landscaping because of the effects of climate change (Ayan et al., 2022; Laaribya et al., 2023). However, the plants to be used in landscaping should also be adaptable to the climatic conditions of the region. At this point, species with high climatic plasticity gain prominence in landscaping.

Photinia × *fraseri* Dress. (Fraser photinia) is an evergreen, and ornamental woody shrub that can grow up to 3-5 meters, and it is widely planted in green areas. This species, which is a member of the *Rosaceae* family, and a hybrid of *P. glabra* and *P. serrulata*. With its impressive leaf characteristics, colours and fast-growing attribute, *P. x fraseri* is a highly preferred plant as a hedge or ornamental plant in parks, gardens and roadside in landscaping. This plant has two types of leaves, green (mature leaves) and red (young leaves). Its perennial foliage is very striking during sprouting due to the new bright-red leaves among the dark green older ones (Bonaminio & Blazich, 1983). Çetiner and Zencirkıran (2020) stated that the taxon is prominent in terms of leaf, flower and fruit characteristics. *P. x fraseri* has strong apical dominance and results in a single leader with an occasional lateral shoot. Pruning is necessary to produce a dense, compact plant in the nursery or landscape. From a landscape maintenance aspect, *P. x fraseri* should be pruned at regular intervals, perhaps after 25 to 30 cm of new growth, to produce a more desirable plant (Dirr, 1984).

Besides its ornamental function, numerous researches have confirmed that *P. x fraseri* has robust resistance to drought (Ugolini et al., 2014; Toscano et al., 2016; Kösa, 2023) and to extreme temperature (Haynes et al., 1992), and also has medicinal benefits (Song et al., 2021). The relatively high specific leaf area, compared with other common shrub species (Wang et al., 2016), assists *P. x fraseri* in developing considerable dust retention ability (Li et al., 2020). Its ability to resist cold weather conditions and air pollution, it is a plant that can grow even in urban areas with arid soil, and poor drainage (Akdemir et al., 2016; Wu et al., 2019; Kösa, 2023). Also, Kösa (2023) reported that the species is moderately resistant to frost and wind, and less resistant to salinity. Kong et al. (2022) stated the morphological changes in *P. x fraseri* under multi-periodic stress.

The economic value of the landscape plants is directly proportional to their growth performance. The faster growing provenances of the same plant reduce the cultivation process and thus the cost which then increases the profit rate (Gülseven et al., 2019; Yucedag et al., 2019a). For this reason, it is of great importance to identify and use the fastest growing ortets, especially in landscape plants in terms of cost and profitability. In this study, five ortets of *P.* × *fraseri* in different districts in Türkiye were compared in terms of their growth performances.

2. Materials and Methods

The study was conducted in the Gokcebey Forest Nursery of Zonguldak, Türkiye (41°19′ N, 32°05′ E, 45 m above sea level), where the annual precipitation is approximately 1242.9 mm and the annual average temperature is 13.5 °C (Atik, 2013). *P*. x *fraseri* cuttings were provided from one ortet from each of Zonguldak, Devrek, Ulus, Alapli, and Eregli districts.

Experiments were conducted in paper pots with the dimension of 13 × 3 cm under greenhouse conditions at 18-22 °C. Seedlings were grown in media containing equal volumes of sand, perlite and forest soil, and the comparisons were made using randomized complete parcels design with three repetitions. No hormone application was performed on the cuttings. In October, 300 seedlings (60 seedlings for each ortet) were uprooted without harming the roots. Subsequently, seedling height (SH), root collar diameter (RCD), leaf length (LL) and leaf width (LW), root length (RL), root number (RN), and last shoot length (LSL) of seedlings were identified.

After measuring seedling heights, the seedlings were cut from the root collar and weighed, and then their stem and root fresh weights (SFW andRFW) and seedling fresh weight (SDFW) were determined. Afterwards, the seedlings were dried for 24 hours at 105 ± 2 °C and weighed, and then their stem dry (SDW), root dry (RDW) and seedling dry weights (SDDW) were determined.

Mean growth characters were calculated and compared among ortets using variance analysis (ANOVA), and adjusted Duncan's multiple range tests ($p<0.05$). In addition, pairwise correlations between seedling characters were evaluated using Pearson's correlation coefficients. Morphological differences among ortets were visualized using an unweighted pair group method with arithmetic mean dendrograms, and hierarchical cluster analyses were performed based on squared Euclidean distances. All statistical analyses were conducted using SPSS statistical software (SPSS, 2011).

3. Results

F values and the means of ortets in terms of seedling size were given in Table 1. Accordingly, the changes in all seedling size characters based on ortets were statistically significant at minimum of 95% confidence level (95% for RL character and 99.9% for other characters). The ortet from Eregli had the lowest values of seedling size-related characters while the ortet from Zonguldak showed the highest values of those. Seedlings of ortet from Zonguldak reached 2.8 times more than seedlings of Eregli ortet in SH and 2.7 times in LL. According to Duncan test, ortets revealed different groups ranging from 2 (RL) to 5 (LW).

Table 1. Changes in seedling size-related characters of ortets.

Location of ortets	SH (cm)	RCD (mm)	LW (cm)	LL (cm)	RL (cm)	LSL (cm)
Zonguldak	29.86 c*	0.81 c	5.27 e	8.91 d	25.20 b	13.43 c
Devrek	28.92 c	0.63 b	5.01 d	8.84 d	23.80 ab	12.10 c
Ulus	23.92 b	0.49 a	3.93 c	7.31 c	22.67 a	13.39 c
Alapli	11.63 a	0.44 a	2.51 b	5.74 b	24.16 ab	10.25 b
Eregli	10.46 a	0.42 a	1.96 a	4.94 a	21.73 a	7.17 a
F Value	*249.364****	*46.164****	*427.102****	*197.243****	*2.905**	*16.781****

*The same letters in the column showed homogeneous ortets.
P-value: *95% confidence level, **99% confidence level, ***99.9% confidence level. ns: non-significant.

F values and the means of ortets in terms of seedling weights were presented in Table 2. The changes in all seedling weight-related characters of ortets were statistically significant at 99.9% confidence level. Eregli ortet had the lowest values of seedlings weight-related characters while Zonguldak ortet showed the highest values of those. According to Duncan test, ortets showed different groups ranging from 2 (RFW) to 4 (SDFW, SDDW, and RDW).

Table 2. Changes in seedling weights of ortets.

Location of ortets	SDFW	SDDW	SFW	RFW	SDW	RDW
Zonguldak	5.09 d*	4.53 d	2.73 c	2.33 b	2.43 c	2.10 d
Devrek	4.77 c	4.22 c	2.59 bc	2.17 b	2.31 c	1.91 c
Ulus	4.13 b	3.51 b	2.52 b	1.62 a	1.94 b	1.34 a
Alapli	3.72 a	3.05 a	1.97 a	1.74 a	1.37 a	1.53 b
Eregli	3.58 a	2.88 a	1.94 a	1.64 a	1.51 a	1.35 a
F Value	*126.801****	*118.163****	*34.541****	*29.577****	*47.924****	*33.719****

*The same letters in the column shows homogeneous ortets.
P-value: *95% confidence level, **99% confidence level, ***99.9% confidence level. ns: non-significant.

The result of correlation analysis among all characters was given in Table 3. As a result of the correlation analysis, no statistically significant relationship at minimum of 95% confidence level was found between RL and SH, and between SFW and SDW, whereas all the other characters were found to have statistically significant ($p>0.05$) and positive relationship among each other. The strongest relationships were found between LL and SH (0.964); LW and LL (0.955); and LW and SH (0.945).

Table 3. The results of correlation analysis.

Variables	SH	RCD	LL	LW	SDFW	SDDW	SFW	RFW	SDW	RDW	RL
RCD	.745**										
LL	.964**	.792**									
LW	.945**	.775**	.955**								
SDFW	.887**	.858**	.923**	.905**							
SDDW	.893**	.806**	.928**	.905**	.957**						
SFW	.866**	.682**	.820**	.820**	.845**	.822**					
RFW	.606**	.747**	.716**	.684**	.820**	.768**	.387**				
SDW	.880**	.728**	.846**	.837**	.890**	.887**	.940**	.528**			
RDW	.602**	.717**	.726**	.671**	.777**	.815**	.401**	.903**	.518**		
RL	.193	.369**	.286*	.284*	.327*	.322*	.248	.295*	.272	.347*	
LSL	.634**	.525**	.630**	.644**	.578**	.556**	.549**	.421**	.515**	.352*	.331*

The dendrogram resulted from hierarchical cluster analysis was given in Figure 1. The ortets were generally grouped into two groups where the Zonguldak, Devrek and Ulus formed one group, and the Alapli and Eregli formed the other group. It was possible to say that the Zonguldak and Devrek were very close to each other as well as the Alapli and Eregli.

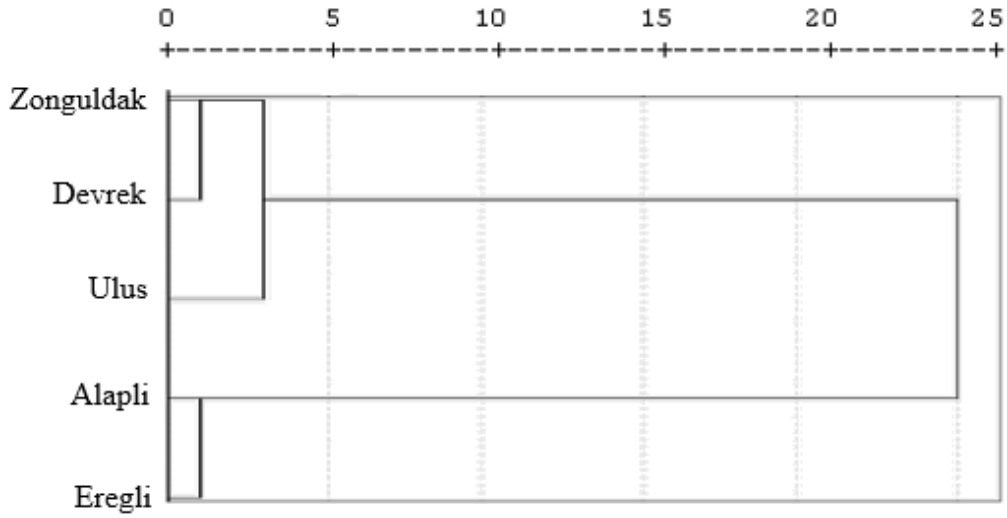

Figure 1. A dendogram of hierarchical cluster analyses.

4. Discussion

Significant differences were found among the ortets in terms of seedling characters, and the difference among the ortets was found to be more than 2.5 times for some characters. The ortets from Zonguldak, Devrek and Ulus were found to have the highest performing seedlings. Çetiner and Zencirkıran (2020) reported that seedling growth characters such as plant height, stem diameter, number of leaves can show great variations according to growing media, and that radically increases in plant characteristics can be achieved in growing media prepared with a suitable substrate.

As known, a fast-growing plant provides great advantages in a lot of ways such as providing advantages over factors such as living cover, reducing the time needed to be supplied to the market commercially, and thus lowering costs, providing greater profitability and increasing the product. The growth performance of plants, in other words the phenotypic characters, come up as a result of the interaction of genetic structure and environmental conditions (Hrivnák et al., 2017), and it is known that each genetic structure may react differently to the same environmental conditions (Yucedag & Gailing, 2012; Guney et al., 2016; Yücedağ et al., 2019b).

Studies conducted to date show that there may be significant differences in both growth performance and other morphological characters, even among individuals of the same ortets, as well as different ortets obtained from different districts of the same species. Therefore, the components of these factors may affect the growth performance, namely the phenotypic characters of plants. As a matter of fact, many phenological, morphological and anatomical characters are significantly affected by environmental factors as well as genetic ones (Özel et al., 2015; Ertugrul et al., 2019; Yücedag et al., 2021).

5. Conclusion

Despite many studies conducted to date on the selection and breeding of fast-growing species in both forestry and agriculture, the species used in landscaping have been neglected to a large extent, and the studies on these species have been limited. However, the selection of the fastest growing ortets in the seedlings produced for landscaping will enable the seedlings to get to a marketable size in a shorter period of time, and thus will considerably increase the profit rate for the producers. Because the landscape application is expected to take its final form as soon as possible, high performance of the landscape plant is of great importance for the practitioners. In this sense, the current study showed that seedling performance can be increased several times only by ortet selection. Therefore, it may be recommended to continue and diversify the studies on the growth performances of different landscape plants.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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