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PROPAGATION PERFORMANCES OF GRAPEVINE WITH CUTTINGS IN DIFFERENT ROOTING MEDIA

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Abstract
Vegetative propagation is one of the most common method used in plant species. Although there are different methods, the most commonly used tool for some fruit species is propagation with cuttings. This method is a practical and low-cost method, but plant species have different performances in this regard. In addition to the species used in propagation by cuttings, the rooting medium used also affects success. Grapevine is known to be species that is easy to propagate by cuttings. In this study, the effects of different rooting media on rooting performances (rooting rate, number of roots, root length) were examined in 'Dimrit' grapevine cultivars. Perlite, pumice, river sand and peat were used as media. One-year-old hardwood cuttings were used as plant material. The experiment was designed with 3 replications and 15 cuttings in each replication. The working environment was a greenhouse, and materials watered from above in the form of misting daily. The cuttings were taken from the environment 90 days after being placed in the environment and the relevant parameters were measured. Significant effects of media on rooting parameters were found. Accordingly, the rooting rate was 100% in perlite, pumice and river sand environment, while it was 9.5% in peat environment. Root length was found to be highest in perlite medium (12.05 cm) and lowest in peat medium (7.26 cm). While the pumice environment provided the highest number of roots (50.2), peat gave the lowest number of roots (12.0). The study reveals that rooting media have different effects on measured parameters in grapevine. While perlite, pumice and river sand were found to be successful media for the propagation of grapevines by cuttings, peat was not found to be effective.

Keywords: grape, dimrit, cutting, rooting media, perlite

1. INTRODUCTION

The history of grapevines reveals a complex evolution and domestication process that began between 7000 and 4000 BC in the Near East and the Caucasus region, with multiple domestication events leading to the cultivation of *Vitis vinifera* (McGovern et al., 2003). The domestication of grapevines involved the selection for traits such as berry palatability, hermaphroditism, muscat flavor, and berry skin color, shaping the modern cultivated varieties (Zohary & Hopf, 2000). Archaeological evidence suggests that the primary center of grapevine domestication was in the Transcaucasian region, spreading to Southern Greece and the Mediterranean region over time (Pinhasi et al., 2005; McGovern, 2009). The cultivation of grapevines played a significant role in ancient societies, being used in religious rituals, daily life festivities, and trade routes, ultimately becoming one of the oldest and extensively cultivated fruit crops (Myles et al., 2011).

The spread of grape cultivation also influenced the development of winemaking techniques and the establishment of vineyards in various regions, contributing to the rich cultural heritage associated with viticulture. The exchange of grapevine varieties and cultivation practices between different

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civilizations further enhanced the diversity and quality of wines produced worldwide. The intricate history of grapevines showcases a fascinating journey of evolution and domestication that dates back thousands of years, originating in the Near East and the Caucasus region. This process involved multiple domestication events that ultimately led to the cultivation of *Vitis vinifera*, shaping the diverse array of modern cultivated varieties we see today (McGovern et al., 2003). While archaeological evidence points to the primary center of grapevine domestication being in the Transcaucasian region, the spread of grape cultivation across Southern Greece and the Mediterranean region highlights the profound impact this fruit crop had on ancient societies (Pinhasi et al., 2005; McGovern, 2009). Beyond its agricultural significance, grape cultivation played a pivotal role in religious rituals, daily festivities, and trade networks, solidifying its status as one of the oldest and most extensively cultivated fruits globally (Myles et al., 2011). The exchange of grapevine varieties and cultivation techniques among different civilizations not only enriched the diversity of wines produced but also contributed to the cultural tapestry associated with viticulture.

According to the Food and Agriculture Organization (FAO) of the United Nations, the world's grape production in 2020 was approximately 77.5 million tons (FAO, 2021). The top 7 leading countries in grape production are Italy, China, the United States, Spain, France, Turkey, and Argentina. Italy is the largest producer of grapes in the world, followed closely by China and the United States. These countries contribute significantly to the global grape production quantities (FAO, 2021).

Türkiye is one of the leading grape producers in the world, with a rich history of grape cultivation. The country's grape production is focused on both table grapes and grapes for wine production (TUIK, 2021). Türkiye aims to increase its grape production quantities each year to meet the growing demand both domestically and internationally. The diverse climate and fertile soil in Türkiye provide ideal conditions for grape cultivation, making it a key player in the global grape market (Yalcin, 2020). Furthermore, Türkiye's strategic geographical location allows for easy access to various markets, facilitating the export of its high-quality grapes to different regions around the world (Altintas, 2019).

Grape propagation involves various methods such as grafting, cuttings, and layering to reproduce grapevines. Grafting is a common technique where a scion (desired grape variety) is attached to a rootstock to grow a new plant (Hartmann et al., 2010; Mullins et al., 1992). Cuttings involve planting a section of a grapevine stem to develop roots and grow into a new plant (Pongrácz, 1983; Keller, 2015). Layering is a method where a branch is bent and covered with soil to encourage root development, leading to a new grapevine. These propagation methods are essential for maintaining grapevine varieties and expanding vineyards. Furthermore, the choice of propagation method can also impact factors such as disease resistance, growth rate, and overall vineyard productivity (Smart & Robinson, 1991; Jackson, 2014). Additionally, the age of the grapevine being used for propagation can also influence the success rate of these techniques, with younger vines generally being more suitable for certain methods like cuttings due to their higher vigor and ability to root more easily. Also in some areas of Türkiye, vines are propagated by cuttings and rootstocks are not used. Because there are no diseases, pests or problems such as drought or lime in the soil or phylloxera. Moreover, the environmental conditions in which the propagation takes place, such as temperature, humidity, and rooting medium, play a crucial role in determining the success of the process and the health of the resulting grapevines (Dry & Coombe, 2004). It is essential to consider the timing of propagation, as certain methods may be more successful during specific seasons or stages of vine growth, ensuring optimal conditions for successful establishment and growth of new grapevines.

Turkey's “Dimrit” grape is a unique and flavorful grape variety that is native to the Aegean region of Turkey. It is known for its sweet and aromatic taste, making it a popular choice for both eating fresh

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and making wine (Özdemir et al., 2018). The Dimrit grape is characterized by its deep purple color and juicy texture, making it a delightful treat for grape lovers (Kara & Yildirim, 2019). In addition to its delicious taste and vibrant appearance, the Dimrit grape also boasts a high concentration of antioxidants, making it a nutritious option for those looking to incorporate more healthful foods into their diet (Altintas & Şahin, 2020).

The grape propagation medium refers to the material or substance used to encourage root development and growth when propagating grapevines. Common propagation mediums include perlite, vermiculite, peat moss, sand, and a mixture of these materials (Creasy & Creasy, 2009; Winkler et al., 1974). These mediums provide a suitable environment for the development of roots and help in the successful establishment of new grapevines (Hartmann et al., 2010). The choice of propagation medium can impact factors such as moisture retention, aeration, and drainage, which are essential for root development and overall vine health (Mullins et al., 1992). It is important to select a well-draining and nutrient-rich medium to support the growth of grape cuttings or other propagation methods effectively (Pongrácz, 1983).

This study aims to investigate the influence of different propagation mediums on the root growth rate and overall survival rates of grapevine cuttings under controlled experimental conditions.

2. MATERIALS AND METHODS

2.1 Research Area

This study was conducted in the Research Greenhouse of the Department of Horticulture, Faculty of Agriculture, Erciyes University.

2.2 Plant Material

The plant material used in the experiment was the Dimrit grape variety (Vitis vinifera L.). Dimrit grape is one of the local and ancient varieties of Anatolia. It has round, sweet, and dark purple berries that are versatile for both fresh consumption and winemaking. It matures late and is resistant to arid climates (Uysal & Yaşasın, 2017; Figure 1).

Figure 1. Dimrit grape cultivar (Kanarya 2019)

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2.3 Experimental Design

The experiment was designed according to a randomized complete block design with three replications. Each replication consisted of 7 grape cuttings, making a total of 21 cuttings (Singh & Chauhan, 2020; MN, 2022).

2.4 Rooting Media

Four different rooting media were used for rooting the cuttings:
- Perlite
- Pumice
- River sand
- Peat

2.4 Experimental Design

The cuttings were planted in the rooting media and kept for 140 days. At the end of this period, the cuttings were removed, and the following parameters were evaluated:

2.4.1 Root Length: The total length of the roots was measured. Root lengths were measured accurately using a digital caliper (Baglyas et al., 2014; Ausari et al., 2023).

2.4.2 Root Number: The number of roots per cutting was determined. The number of roots was counted manually for each cutting (Ali & Saif, 2013; BN et al., 2023).

2.4.3 Callus Formation: The number of cuttings forming callus was determined. Callus formation was identified by the presence of a cellular structure at the rooting region (Hussein et al., 2021; Abbas, 2014).

2.4.4 Statistical Analysis

The data obtained were analyzed using the SPSS 27 statistical package program. Appropriate statistical tests were applied to determine the differences between the means (Singh & Chauhan, 2020; MN, 2022; Shah et al., 2021).

3. RESULTS AND DISCUSSIONS

Perlite demonstrated superior performance, with an average root length of 12.05 cm and 33.6 roots per cutting. All 21 cuttings rooted successfully, with 100% callus formation. These results are consistent with Singh and Chauhan (2020) and Hussein et al. (2021), who noted perlite's excellent balance between air and water retention, which is crucial for enhancing rooting. Additionally, Singh and Kumar (2021) emphasized perlite's consistent performance in promoting healthy root systems across various plant species. The lightweight structure of perlite allows for good root aeration while retaining sufficient moisture to support root development, making it an optimal choice for rooting cuttings. Its lightweight structure and high water retention capacity, combined with excellent aeration, create an ideal environment for root initiation and development. The high rooting and callus formation rates indicate that perlite can consistently provide the necessary conditions for cuttings to thrive (Table 1, Figure 2).

Pumice also exhibited high effectiveness, with an average root length of 10.19 cm and 50.2 roots per cutting. All 21 cuttings rooted successfully, with 100% callus formation. The high porosity and drainage properties of pumice enhance oxygen uptake, promoting robust rooting, as noted by Shah et al. (2021) and MN (2022). The mineral content of pumice might contribute to root development, supporting findings by Ali and Saif (2013). Pumice's ability to prevent waterlogging while maintaining adequate moisture levels creates an ideal rooting environment, resulting in vigorous root systems. The high porosity of pumice ensures optimal oxygen availability, preventing waterlogging

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and supporting root development. The mineral content of pumice may also play a role in enhancing root growth, making it a highly effective medium for grapevine cuttings (Table 1, Figure 2).
River sand provided good results with an average root length of 8.51 cm and 38.0 roots per cutting. All 21 cuttings rooted successfully, with 100% callus formation. Although the root length was shorter compared to perlite and pumice, river sand's effective aeration and drainage properties support successful rooting. This aligns with findings from Baglyas et al. (2014) and Hussein et al. (2021). Ausari et al. (2023) also confirmed the effectiveness of river sand for hardwood cuttings, emphasizing its optimal balance of air and moisture, which is crucial for root development and health. While river sand has lower water retention compared to perlite and pumice, its excellent drainage properties prevent waterlogging, ensuring sufficient aeration for root development. Frequent watering might be necessary to maintain adequate moisture levels, but its balance of air and moisture supports effective rooting (Table 1, Figure 2).

Table 1. Root lenght and root number of Dimrit grape cultivar on each rooting media

Rooting Media	Root length (cm)	Number of roots	Number of rooted plants	Number of non-rooted plants	Rooting percent (%)
Perlite	12,05 ± 1,46 a	33,6 ± 9,65 a	21	0	100
Pumice	10,19 ± 1,47 ab	50,2 ± 19,17 a	21	0	100
River sand	8,51 ± 1,00 b	38,00 ± 9,02 a	21	0	100
Peat	7,26 ± 7,04 b	12,0 ± 9,89 b	2	19	10,52

Figure 2. Effects of different rooting media on rooting of cuttings of Dimrit grape cultivar

Peat had the lowest performance, with an average root length of 7.26 cm and 12.0 roots per cutting. Only 2 out of 21 cuttings rooted, resulting in a rooting percentage of 10.53%, and no callus formation was observed. The high water retention and poor aeration of peat often lead to insufficient oxygen for cuttings, causing root rot, as noted by Sengel et al. (2012) and MN (2022). Singh and Kumar

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(2021) also highlighted that peat may not be suitable for cuttings due to its propensity to create anaerobic conditions, despite its benefits for seed starting. Despite its high water retention capacity, peat's poor aeration can lead to anaerobic conditions, detrimental to root growth. The low rooting and callus formation rates highlight peat's unsuitability for grapevine cuttings, as it can cause root rot and hinder root development (Table 1, Figure 2).

Based on statistical analysis, on the root lenght data, perlite resulted in significantly longer roots, compared to river sand and peat. While pumice was not significantly different from either perlite or river sand but was better than peat. The high standard deviation for peat indicates high variability in root length measurements (Table 1).

The number of roots was highest in Pumice, followed by River sand and Perlite, all of which were grouped together statistically. Peat had significantly fewer roots. The high standard deviation for Pumice and Peat indicates more variability in root numbers in these media (Table 1).

Perlite, Pumice, and River sand all resulted in the maximum number of rooted plants (21 each), while Peat resulted in only 2 rooted plants. This difference indicates a significant impact of the rooting media on the success rate of rooting (Table 1).

4. CONCLUSIONS

The analysis underscores the critical role of rooting media in the propagation success of grapevine cuttings. Perlite and pumice emerged as the most effective media, with high rooting rates and robust root development. River sand also performed well, though with slightly lower root length and number. Peat, however, proved to be the least effective, with very low rooting and no callus formation. These findings emphasize the need for careful selection of rooting media to ensure successful propagation of grapevines.

This conclusion aligns with Abbas (2014), who emphasized the importance of selecting appropriate rooting media to optimize propagation success. Aboogiala et al. (2021) and BN et al. (2023) highlighted the impact of rooting media on growth, particularly when combined with hormone treatments like IBA. Ausari et al. (2023) stressed the necessity of choosing suitable media for hardwood cuttings to ensure optimal root development and plant health.

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