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# EFFECTS OF DIFFERENT STORAGE CONDITIONS ON ROOTING AND SHOOTING PERFORMANCE OF GRAPEVINE (*Vitis Vinifera* L.) CUTTINGS IN HYDROPONIC CULTURE SYSTEM

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## *ABSTRACT*

The shortfall in grapevine planting materials urged the researchers to enhance rapid propagation techniques with successfully storing the propagation materials such as rootstock and scion canes. The present study was conducted to assess the effects of different storage conditions (cold storage room at 1 °C plus 80-90% relative humidity and sand medium in open area) on rooting and shooting performance of cuttings of seven grapevine cultivars. For assessments, a hydroponic culture system was established in which the cuttings were rooted. Investigations on the cuttings prepared from the canes sampled at 6th, 7th and 8th months of the storage times showed that cold storage room significantly maintained the quality of canes with better callusing, rooting and shooting features. Storage at cold room can be recommended for long term storage, while dipping the canes in damp sand medium can be considered for a short time around a few months keeping of grapevine canes. Grapevine cultivars exhibited slight variation in response to both storage duration and storage conditions.

**Contribution/Originality:** This research is one of very few studies which have investigated the healthy and practical maintenance of propagation materials by comparing the scientific storage room and indigenous farming strategy conditions.

## 1. INTRODUCTION

Globally increasing demand for grapes and its derivatives has resulted in shortfall in planting materials. Therefore improvement of strategies in grapevine multiplication is an essential issue for overcoming the plant material deficit and potentially cost-effective sapling production. This can be only succeed by selecting the most convenient conditions such as rooting media, rooting inducer chemicals or cutting sizes. As commonly known, there have been many attempts carried out to induce rooting ability of cuttings by various treatments such as plant growth regulators, rooting media substances (Celik and Agaoglu, 1983). However, certain factors like rooting media, use of chemical substances and storage condition of propagation materials directly influence the success and cost of sapling propagation (Sabir *et al.*, 2004). Although grapevines are known as relatively easy plants to propagate, it requires attention to produce the millions of vines of high quality that are needed globally every year for new plantings and replanting diseased or uneconomic vineyards. Grapevine propagation techniques include in vitro propagation (Barlass *et al.*, 1982) hardwood cuttings (Sabir *et al.*, 2004) softwood cuttings (Warmund *et al.*, 1986) grafted cuttings (Sabır and Ağaoğlu, 2009) and field grafting of rooted rootstock cuttings. To match the

increased demand stemming from the expansion of the grape industry, modern grapevine nurseries have evolved to resemble like factories, with operators working at single tasks on streamlined production lines. But, the high in-house wastage rates up to 40–60% reported by nurseries worldwide are indicative of the problems faced by the nursery industry. In spite of remarkable progress towards modernization (Borsellino *et al*., 2012) the most significant issue remains the ability of nurseries to maintain a consistent supply of healthy propagation materials. This necessitates detailed descriptions and applications of the practices that result in the production of high-quality cuttings, grafting materials and saplings coupled with the comprehensive quality standards. The first step in the grapevine propagation process is the harvesting of cuttings and their transport from the mother vine block to the nursery. To maintain quality of grafting materials, a well-managed harvesting operations in mother vine blocks are critical (Daughtrey and Benson, 2005) because the cuttings left lying on the vineyard floor are liable to suffer dehydration, contamination by organisms and frost damage. If the ambient winter temperature is above 4 °C, the respiration rate and water loss of the material increases. Grafting materials that are not to be processed immediately can be stored in a clean, cool room (Waite *et al*., 2015) but practically, growers bury them into sand after pruning up to grafting operation. But this method leads to serious failures in grafting. Cane materials are usually kept for a long time before planting or grafting. However, inconvenient keeping conditions commonly cause significant loses in viability and cleanliness of materials. Therefore, effects of different storage conditions on rooting and shooting performance of cuttings taken from canes belonging to seven different grapevine cultivars (*Vitis vinifera* L.) were investigated using hydroponic culture system.

## 2. MATERIALS AND METHODS

In the present investigations, canes of seven grapevine cultivars belonging to *Vitis vinifera* L. species were used. The hardwood canes used in this research were taken from dormant vines grown in mountainous grape growing regions of Konya, Turkey in autumn about one month after leaf fall (Dardeniz *et al*., 2007). Basal parts containing three to five buds and the tips of canes were removed to ensure equality in materials. The canes were prepared about 70±5 cm long and 1.0±0.2 cm thick including 12-15 buds each. To prevent the growth of moulds particularly *Botrytis cinerea* on the canes in cold storage, cuttings have previously subjected to a brief fungicidal dip (Fourie and Halleen, 2006). A total of thirty canes were used for each storage condition per cultivar. Canes were stored in two different conditions; (1) in a clean, cool room at 1–2 °C in clean polyethylene bags with several small, well-spaced, 7–10 mm holes that allow air to reach the cuttings without danger of dehydration (Hartmann *et al*., 2001) and (2) in damp sand medium as done by certain growers.

In order to compare the effects of storage conditions, callusing rate, rooting level, shooting rate and rooting rate in cuttings were investigated at 6$^{th}$, 7$^{th}$ and 8$^{th}$ months of storage duration. For each sampling month, ten canes were taken to prepare cuttings. Cuttings from nearer the apical region (the first three nods) were discarded as proposed by Keeley *et al*. (2004). Cuttings including one healthy bud each were placed into water culture for rooting process. A hydroponic culture system was established in which the cuttings were rooted. In the system, the basal 1 cm parts of the cuttings were soaked into the water. The water in the culture was changed with four days interval. The 5 cm long cutting samples from each cultivar were fixed with several floating platforms made of styrofoams and placed with distances of 2 x 4 cm at plastic containers. Basal ends of cuttings were dipped into the water as displayed in Figure 1. The hydroponic culture was maintained under laboratory condition with 21±4°C. The water reservoir in the system was recirculated with an air pump. The experimental design was completely randomized parcels with three replications. Each replication consisted of ten cuttings. After a 40 d rooting duration in culture, callus degree basal section of cuttings was determined by using 0-4 scale; 0: No callusing, 1: 1%-25% callusing, 2: 26%-50% callusing, 3: 51%-75% callusing and 4: 76%-100% callusing at graft union (Kamiloglu and Tangolar, 1997). Callusing rate was recorded as percentage by using callus formation around the cut surfaces. Rooting level (1-4 scale) and rooting rate (%) were also recorded.

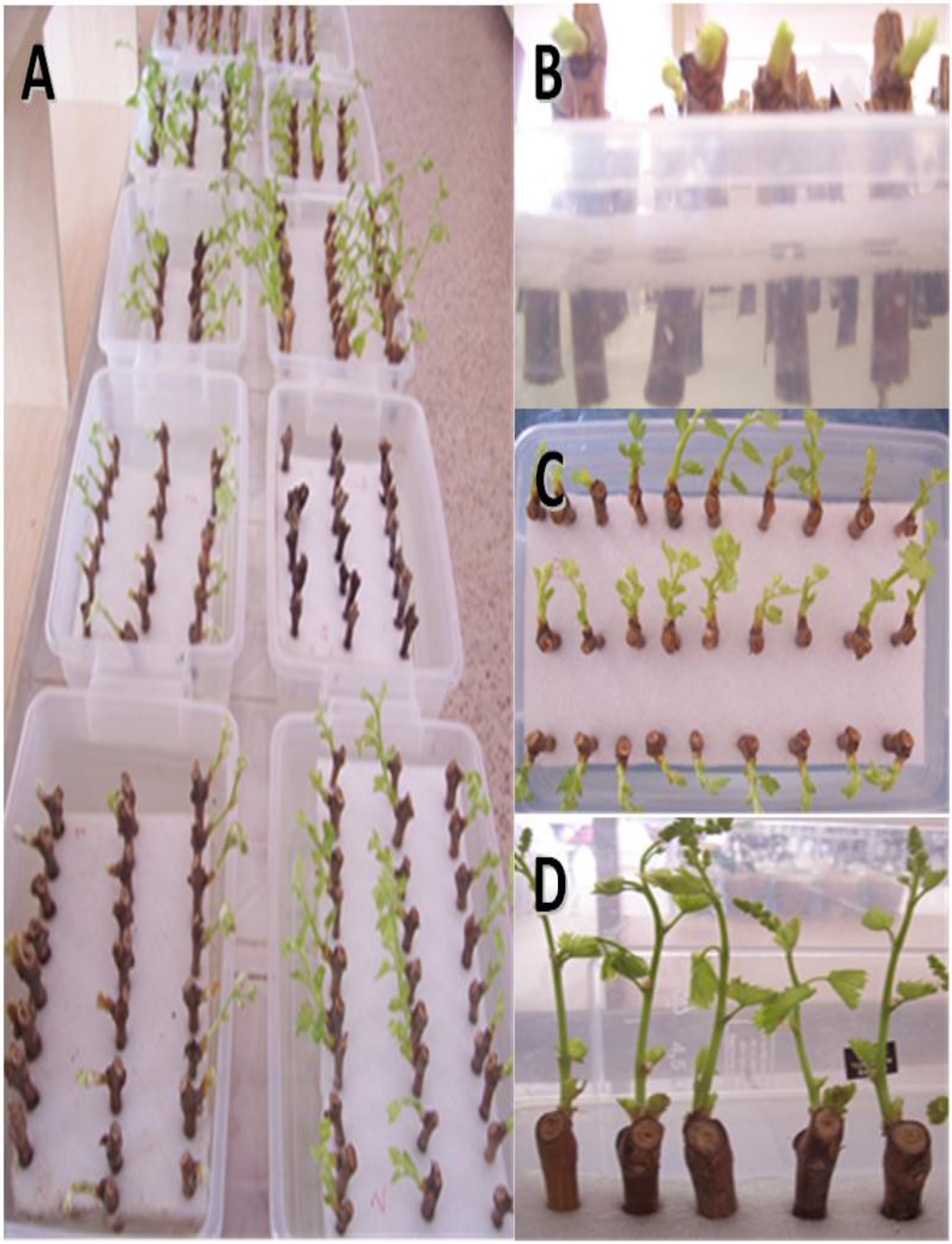


**Figure-1.** Cutting samples from each cultivar at containers fixed with styrofoam. Bud break stages (A), basal end callusing stages in water (B), sprouting (shooting) stages (C), and final investigating stages (D).

## 3. STATISTICAL ANALYSES

Cultivars were separately analyzed due to fact that the existence of genetic differences among the genotypes in response to rooting or shooting potential. Data were evaluated by analysis of variance (ANOVA) and means were separated by Tukey's Least Significant Differences (LSD) test.

## 4. RESULTS AND DISCUSSION

As illustrated in Table 1, callusing levels of cuttings prepared from stored canes displayed significant variation in response to storage condition. In the 6th month of storage, callusing levels among the storage condition were very similar in three cultivars (Ekşi Kara, Narince and Göküzüm), while the others presented significant differences. Afterwards, callusing levels of the cuttings underwent a remarkable decrease along with the prolonged storage time. In the 7th and 8th months of storage, cuttings from cold room storage conditions had significantly higher callusing levels than those taken from damp sand condition for all of the cultivars. Callusing level is one of the most important parameters to evaluate propagation success (Tangolar *et al.*, 1997). Studies have already revealed that a good callus formation all around the basal end of the cutting is desired for subsequent health of planting material (Saraswat, 1973). Cold storage room resulted better callusing among the cuttings of overall cultivars used in the present study.

**Table-1.** Changes in callusing level (1-4 scale) as influenced by storage conditions.

| Cultivar | Storage | Storage duration (months) | | |
|---|---|---|---|---|
| | | 6. | 7. | 8. |
| Ekşi Kara | Sand | 3.60 | 2.47 b | 2.47 b |
| | Room | 3.67 | 3.□3□a | 3.33 a |
| Sultani Çekirdeksiz | Sand | 3.67 b | 2.87 b | 2.67 b |
| | Room | 4.00 a | 3.60 a | 3.47 a |
| Narince | Sand | 3.60 | 2.47 b | 2.13 b |
| | Room | 3.50 | 3.47 a | 3.27 a |
| Alphonse Lavallée | Sa□d | 3.33□ | 3.13 b | 2.67 b |
| | Room | 3.80 a | 3□53 □ | 3.13 a |
| Büzgülü | Sand | 3.27 b | 2.47 b | 2.07 b |
| | Room | 3.87 a | 2.73 a | 2.67 a |
| Göküzüm | Sand | 3.93 | 2.87 b | 2.67 b |
| | Room | 4.00 | 3.93 a | 3.20 a |
| Siyah Dimrit | Sand | 3.60 b | 3.27 b | 2.73 b |
| | Room | 4.00 a | 3.73 a | 3.67 a |

**Table-2.** Changes in rooting level (1-4 scale) as influenced by storage conditions.

| Cultivar | Storage | Storage duration (months) | | |
|---|---|---|---|---|
| | | 6. | 7. | 8. |
| Ekşi Kara | Sand | 3.33 | 2.27 b | 2.13 b |
| | Room | 3.67 | 3.80 a | 3.27a |
| Sultani Çekirdeksiz | Sand | 2.87 b | 2.33 b | 2.27 b |
| | Room | 3.87 a | 3.67 a | 3.60 a |
| Narince | Sand | 3.00 | 2.40 b | 2.07 b |
| | Room | 2.93 | 3.67 a | 3.07 a |
| Alphonse Lavallée | S□nd | 2.93 | 2.47 b | 1.93 b |
| | Room | 3.27 | 3.67 a | 2.□7 a |
| Büzgülü | Sand | 2.93 b | 3.27 | 1.87 b |
| | Room | 3.73 a | 3.33 | 3.07 a |
| Göküzüm | Sand | 3.87 | 3.27 b | 2.73 b |
| | Room | 4.00 | 4.00 a | 3.33 a |
| Siyah Dimrit | Sand | 3.33 b | 3.07 b | 2.53 b |
| | Room | 3.87 a | 3.93 a | 3.73 a |

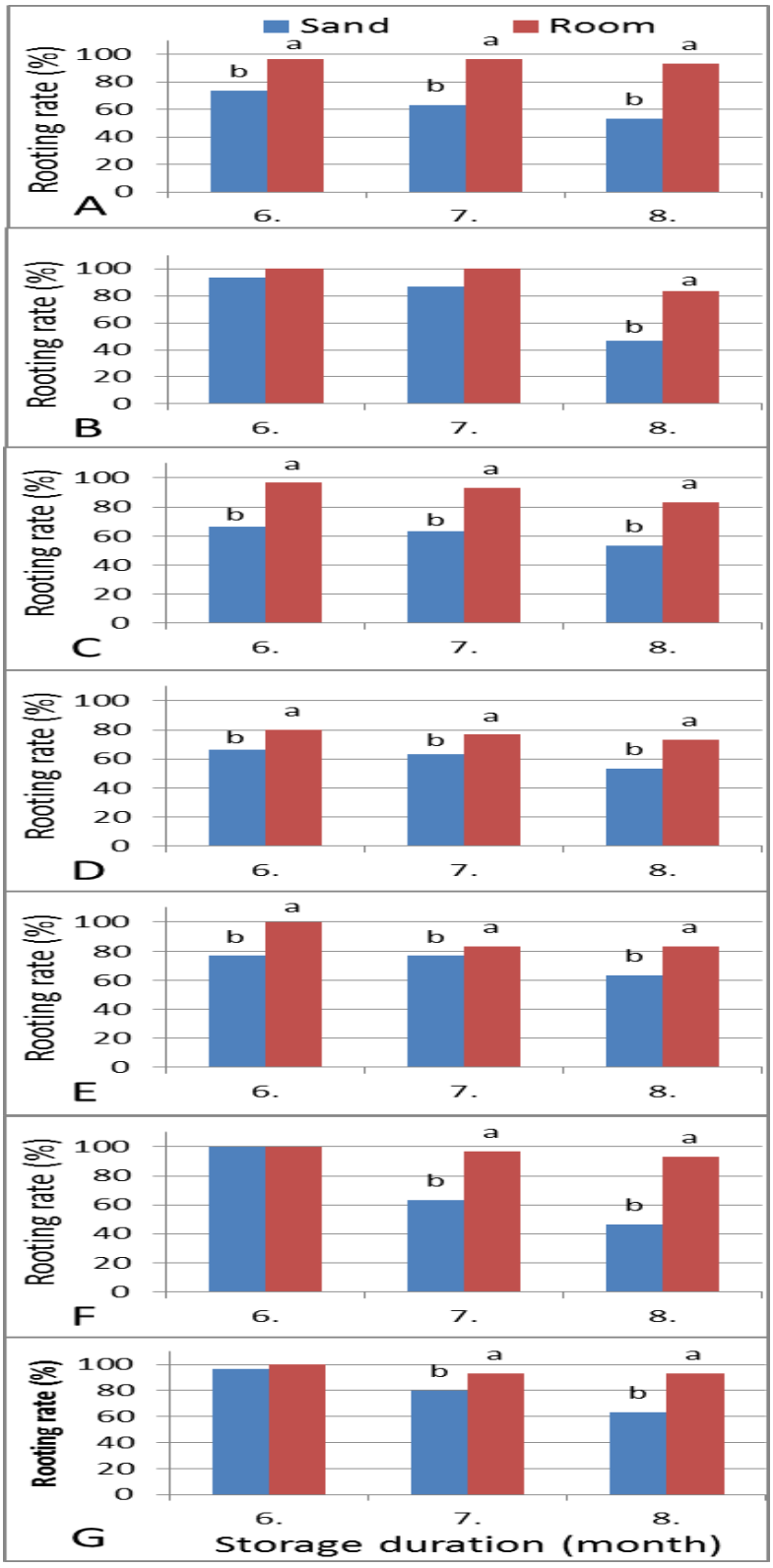


**Figure-2.** Changes in rooting rate (%) as influenced by storage conditions (A: Ekşi Kara, B: Sultani Çekirdeksiz, C: Narince, D: Alphonse Lavallée, E: Büzgülü, F: Göküzüm, G: Siyah Dimrit).

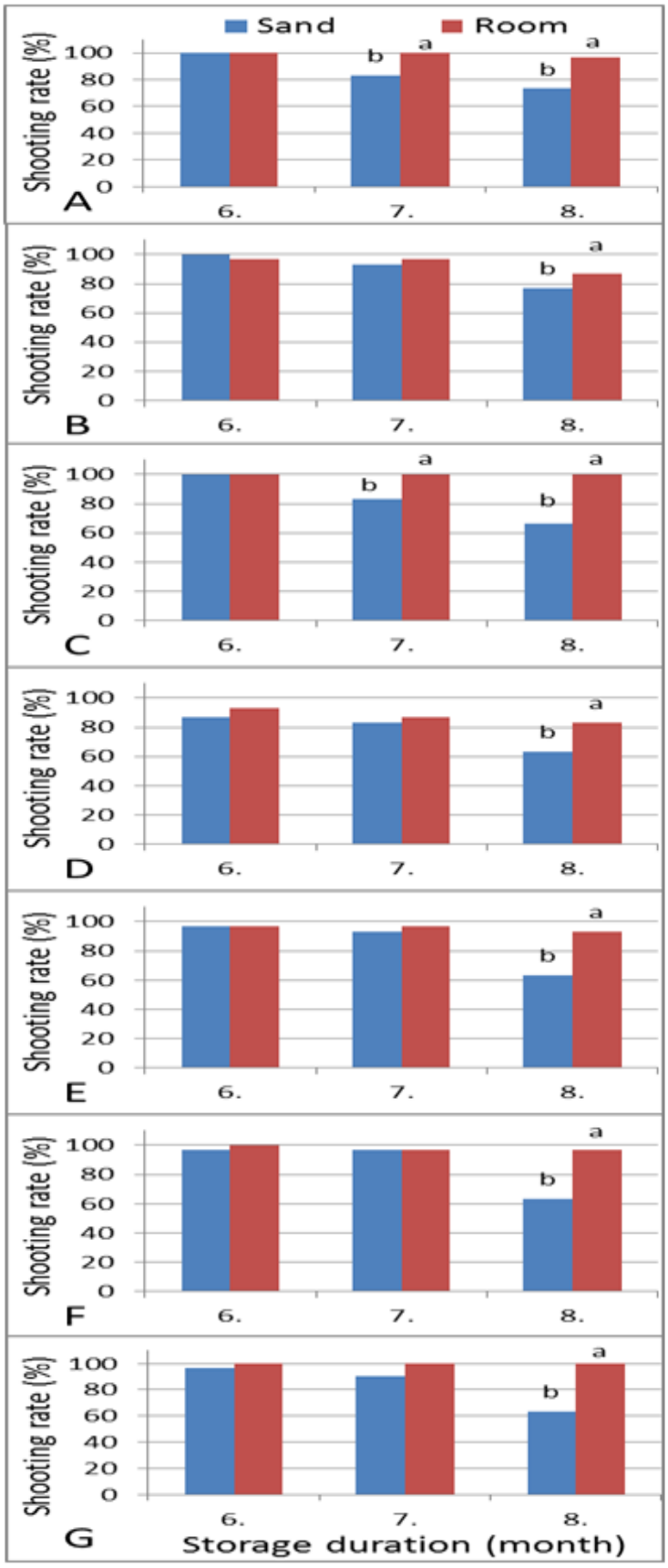


**Figure-3.** Changes in shooting rate (%) as influenced by storage conditions (A: Ekşi Kara, B: Sultani Çekirdeksiz, C: Narince, D: Alphonse Lavallée, E: Büzgülü, F: Göküzüm, G: Siyah Dimrit).

Changes in rooting level of cuttings were summarized in Table 2. According to observations in the 6th month, storage conditions had no significant effect on rooting levels of four cultivars (Ekşi Kara, Narince, Alphonse Lavallée and Göküzüm), while the rooting levels of cuttings from room condition were significantly higher than those from sand in three cultivars. Findings on rooting level were just similar to those obtained on callusing level, indicating the importance of a good callus emergence in vegetative propagation as indicated by Smith *et al.* (2012).

Figure 2 depicts the variation in rooting percentage of cuttings after storage treatments. Among the cuttings sampled after the 6th month of storage, there were significant differences in most of the cultivars used (Ekşi Kara, Narince, Alphonse Lavallée and Büzgülü), although Sultani Çekirdeksiz, Siyah Dimrit and Göküzüm did not significantly responded. The last three cultivars have a high rooting percentage. Indeed, all the cuttings have more than 60% rooting rate which can be commercially acceptable. Expectedly, rooting level of the cuttings decreased along with the prolonged storage duration. At the 7th month of storage, the cuttings prepared from canes kept at storage room have always significantly (with an exception of Sultani Çekirdeksiz) higher rooting rates than those of sand medium. The rooting rates of cultivars generally fell within the values obtained on various cultivars in studies (Celik and Agaoglu, 1983; Sabir *et al.*, 2004). The cold storage condition had a remarkable positive influence on maintenance of the health of canes. According to final investigations at 8th month, rooting rates of all the cuttings were higher than 70.0%, while on the other hand this rate was as low as 46.7% (for Sultani Çekirdeksiz and Göküzüm).

Shooting rates (%) of cuttings were illustrated in Figure 3. After the 6th month of the storage, almost all of the cuttings sprouted, except for Alphonse Lavallée with a shooting level around 85-90%. Afterwards, shooting rate markedly decreased in especially cultivars Ekşi Kara and Narince with significant differences among the storage conditions at 7th month of storage. The greatest changes in shooting rate were observed at the end of the 8 month storage duration. According to final investigations, the cuttings prepared from the canes stored in sand have always lower shooting rates than those stored at cold storage room. Values on shooting rate were considerably higher than those of rooting rate indicating that there were significant amount of cuttings displayed shoot growth without

Root development. Markedly higher shooting levels in cold stored samples proves the general knowledge that grapevine budbreak generally improves with increased exposure to chilling temperatures as stated by Dokoozlian (1999).

## 5. CONCLUSION

Effects of two different storage conditions (cold storage room at 1–2 °C in clean polyethylene bags and damp sand medium in open area under commercial farm condition) on rooting and shooting performance of grapevine (*Vitis vinifera* L.) cuttings were investigated using hydroponic culture system. Investigations on the cuttings prepared from the canes sampled at 6th, 7th and 8th months of the storage times, showed that cold storage room significantly maintained the quality of canes with better callusing, rooting and shooting features. Storage at cold room can be recommended for long term storage, while dipping the canes in damp sand medium can be considered for a short time keeping of grapevine canes. Grapevine cultivars exhibited slight variation in response to both storage duration and storage conditions.

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**Contributors/Acknowledgement:** Both authors contributed equally to the conception and design of the study.

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