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Effects of Cutting Size, Rooting Media and Planting Time on Rooting of Domat and Ayvalik Olive (*Olea europaea L.*) Cultivars in Shaded Polyethylene Tunnel (Spt)

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Abstract : Domat (difficult to root) and Ayvalık (easy to root) are important olive cultivars for green table olives and olive oil respectively in Turkey. This research was carried out to obtain ready to sale nursery plants of Domat and Ayvalık. It was achieved rooting their cuttings in different sizes and under different media and taken in different times of the crop year in Shaded Polyethylene Tunnels (SPT). Cuttings were prepared in three sizes: 1, 2 and 3 nodes with two leaves. Rooting media was; I. Control (Sand), II. (Perlite: Peat: Sand: Silt) (1:1:1:1), III. (Perlite: Peat: Sand: Silt) (1:2:1:2), IV. (Perlite: Peat: Sand: Silt) (1:1:2:2), V. (Perlite: Peat: Sand: Silt) (0:0:1:1) and VI. (Perlite: Peat: Sand: Silt) (1:0:1:1). Cuttings were kept in SPT for 60 days for rooting and then kept under shade for another 30 days. Vegetative growth characteristics were determined by studying percent survival rate, callus development and rooting. While, Ayvalık cuttings formed both callus and roots, Domat cuttings formed only callus. The highest callus formation (70%) was observed on Ayvalık cuttings (1 node) taken in May in 1:0:1:1 rooting media, but the highest rooting (40%) was observed on cuttings of three nodes in the same date and media. In Domat, the highest callus was formed on cuttings (3 nodes) in May in 1:2:1:2 media. The rooting was very low in Domat however, as it was for Ayvalık too. This was probably because rooting media did not form a suitable environment for adventitious root formation. Cuttings with 1, 2 and 3 nodes carrying 2 leaves differed in percent rooting with different treatments. All three sizes of cuttings can be used in propagation by rooting for the economical use of stock material.

Key Words: Olive, *Olea europaea* L., domat, Ayvalık, SPT (shaded polyethylene tunnel), cutting size, rooting media

Domat ve Ayvalık Zeytin (*Olea europaea L.*) Çeşitlerinin Gölgeli Plastik Tünel Altında Köklendirilmesine Zaman, Çelik Boyu ve Ortamın Etkisi

Öz : Domat (zor köklenen) ve Ayvalık (kolay köklenen) zeytin çeşitleri Türkiye için sırasıyla yeşil sofralık ve yağlık olarak önemlidir. Bu çalışmanın amacı Domat ve Ayvalık çeşitlerinin satışa hazır fidan elde etmektir. Bu, farklı boyutlarda ve farklı zamanlarda alınan çeliklerin, farklı ortamlarda ve Gölgeli Plastik Tünel (GPT) altında köklendirilmesi ile elde edilmiştir. Çelikler 1, 2 ve 3 boğumlu olarak 3 boyutta hazırlanmıştır. Köklendirme ortamları: I. Kontrol (kum), II. (Perlit: Turba: Kum: Mil) (1:1:1:1), III. (Perlit: Turba: Kum: Mil) (1:2:1:2), IV. (Perlit: Turba: Kum: Mil) (1:1:2:2), V. (Perlit: Turba: Kum: Mil) (0:0:1:1), VI. (Perlit: Turba: Kum: Mil) (1:0:1:1). Çelikler SPT ortamında 60 gün köklendirme amacıyla ve takibinde 30 gün süreyle gölgede tutulmuştur. Çeliklerde canlılık oranı, kallus oranı ve köklenme oranı ile vegetative gelişme belirlenmiştir. Ayvalık çeliklerinde hem kallus hem de kök oluşurken, Domat çeliklerinde sadece kallus oluşumu gözlenmiştir. En yüksek kallus (%70) oluşumu 1 boğumlu Ayvalık Mayıs çeliklerinde ve 1:0:1:1 ortamında elde edilirken en yüksek köklenme (%40) oranı aynı ortam ve tarihte fakat 3 boğumlu çeliklerde elde edilmiştir. Domat çeşidinde ise en yüksek kallus oluşumu yine Mayıs fakat 3 boğumlu çeliklerinde ve 1:2:1:2 oratmında gözlenmiştir. Köklenme oranı hem Domat hem de Ayvalık çeliklerinde çok düşük olmuştur. Bu da belki köklendirme ortamı olarak seçilen ortamların adventif kök oluşumu için uygun olmamasından kaynaklanabilir. Oysa anaç materyalin daha ekonomik olarak değerlendirilmesi için her üç boydaki iki yapraklı çeliklerin kullanılmasının uygun olduğu belirlenmiştir.

Anahtar Kelimeler: Zeytin, *Olea europaea* L., domat, Ayvalık, GPT (gölgeli plastik tünell), çelik boyu, köklenme ortamı

Introduction

In order to protect the genetic information of plants in higher plants vegetative propagation methods are used. The economic method of vegetative clonal propagation is cuttings (Davies and Hartman 1988). In fact, Rugini and Fedeli (1990) reported that the biggest problem in vegetative propagation, in some species and varieties, is the low ability of regeneration leading to low percentage of rooting. For some plants, because of this low percentage of rooting, it is not economically viable to use vegetative propagation through the use of cuttings.

Factors that influence the successful rooting of cuttings are reported by Garner and Chaudri (1976), Hartman et al (1990) as: age of mother plant, season of cutting, type and height of cutting, presence or not of vegetative buds or leaves on the cutting, water content and ingredient of stock plant and cutting.

All Mediterranean countries have one or two economically very important but difficult to root olive cultivars. For instance, the Gordal cv. of Spain, the

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Kalamata cv. of Greece. So far, research in rooting has not been successful for these varieties. Domat, a very important domestic variety of table olive cultivar of Turkey which is another example of a plant having difficulties in rooting. Using mist propagation systems there is only a 10-20% success rate in rooting. That's why grafting methods are used. Even special applications using SPT (Shaded Polyethylene Tunnel) and putrescine+IBA have only a 30% success rate of rooting (Ozkaya and Celik, 1993). Because of this problem of low success rate in rooting, the cost of nursery plant increases and the production of nursery plant decreases.

This research was carried out to obtain directly rooted plants of Domat and Ayvalık cvs. in SPT by using different cutting size and planting time in 2002-2003.

Material and Methods

The location of the SPT and the shaded place was located in Edremit Olive Nursery Station of Ministry of Agriculture and Rural Affairs (in Edremit, Balikesir, Turkey) and was used for this study from June 2002 to July 2003. For measurements, the laboratory of the same nursery was also used.

As plant materials, two different Turkish olive tree cultivars (*Olea europaea* var. Domat and *Olea europaea* var. Ayvalık) were used. Domat is a difficult to root cultivar while Ayvalık is an easy one. Cuttings were taken from stock plants in the nursery at 2 months intervals for one year. July 2002 cuttings under SPT first month lost their viability, in August 2002 again cuttings prepared though resist only two months and died. Even had done some changes on SPT we had same situation with cuttings of October 2002. Only the cuttings of December, February and April 2003 were succeded.

The cuttings were prepared in three sizes: 1, 2 and 3 nodes carrying two leaves. The number of cuttings in each cultivar was totally 540. For each node 180 cuttings was prepared. Every two months for the duration of a year, six different rooting media were prepared with different ratio of Perlite: Peat: Sand: Silt; I. Control (Sand), II. Perlite: Peat: Sand: Silt (1:1:1:1), III. Perlite: Peat: Sand: Silt (1:2:1:2), IV. Perlite: Peat: Sand: Silt (1:1:2:2), V. Perlite: Peat: Sand: Silt (0:0:1:1), VI. Perlite: Peat: Sand: Silt (1:0:1:1).

In order to protect the cuttings from fungus disease, especially *Cycloconium oleainium* they were immersed for 10 min in 150mg/10lt Benlate solution in batches of 30 cuttings at a time. Then 4000 ppm of IBA was applied for 10 sec. in the last 2-3cm of the cutting. Cuttings were stuck in black Polyethylene bags 8x14 cm that had 4 holes for water drainage. Finally they were grown under SPT.

In this experiment to detect the vegetative growth characteristics during the crop year observations of cuttings was realized every 90 days. Cuttings were kept in SPT for 60 days for rooting then transferred to shade for another 30 days. Vegetative growth characteristics were determined by survival rate (dead or alive) (%), callus development (yes, none) (%) and rooting rate (yes, none) (%). Survival rate is important in order to see the effect of medium on survival of cuttings even when there was no rooting.

Results

Cuttings were taken from stock plants in the nursery at 2 months intervals for one year. July 2002 cuttings under SPT first month lost their viability. In August 2002 again cuttings prepared though resist only two months and died. Even had done some changes on SPT same situation was observed with cuttings of October 2002. Only the cuttings of December, February and April 2003 were succeded

For the December 2002 cuttings, the only data observed was for survival rate, in both cultivars. Actually, more than half of the cuttings in the media II and III died. The highest survival rate was observed on cuttings in control media (sand) and it was between 83.33 and 93.33% (Fig. 1).

For the cuttings, which were put in SPT on 05.02.2003 and collected from shaded place on 11.05.2003 and the callus, rooting and survival rate measurements were done. It was observed that 10% to 36.67% of Domat cv. cuttings in the media I, II and III formed callus while 10% to 70% of the Ayvalık cv. cuttings in the media IV, V and VI, formed calli. There was no callus formation in the Domat cv. for the media IV, V and VI (except for the 2 nodes cuttings in medium VI). Also, there was no callus formation for Ayvalık cv. in the media I, II and III (except in the 2 nodes cuttings in medium III) (Fig. 2).

In February 2003 (05.02.2003), the Domat cv. cuttings formed callus in the media I, II, and III. No rooting was observed in any of the media. The Ayvalık cv. cuttings did not form roots in the media I, II and III. The Ayvalık cv. cuttings formed the most rooting in medium VI with 40% rooting in the 3 nodded cuttings, next in medium VI with a 23.33% rooting in the 2 nodded cuttings and finally in medium IV with a 13.33% rooting in the 2 nodded cuttings. In all 3 media (IV, V and VI) the 1 and 2 nodded cuttings formed rooting, while the 3 nodded cuttings only formed rooting in media V and VI (Fig. 3.)

For February 2003 (05.02.2003) the Domat cv. cuttings in the media I, II and III and the Ayvalık cv. cuttings in the media IV, V and VI kept their survival rate for all three nodded cuttings. Cuttings in the Domat cv. showed a survival rate of 26.67% to 100% for the 1 nodded cuttings, 40% to 93.33% for the 2 nodded cuttings and 26.67% to 100% for the 3 nodded cuttings. In the media IV and V, there were no alive cuttings for the Domat cv. In medium VI the survival rate percentage was between 3.33% and 10%. For the Ayvalık cv. cuttings the 1 nodded cuttings did not show any survival rate in medium I but in the media II, III, IV, V and VI the survival rate percentage was between 20% and 83.3%. 2 nodded

cuttings did not show any survival rate in medium 2 but in the media I, III, IV, V and VI the survival rate percentage was between 3.33 and 90%. 3 nodded cuttings did not show any survival rate in the media I or III but in the media II, IV, V and VI the survival rate percentage was between 23.33% and 100% (Fig. 4.)

For the cuttings, which were put in the SPT on 08.04.2003 and taken out from the shaded place on 08.07.2003 callus formation, rooting and survival rate data was observed only on Ayvalık cv.

Callus formation was observed in the medium V followed by the media I, VI and IV. There was not callus formation in the medium II. The most callus formation was observed on the medium V in the 1 nodded cuttings. In addition, in 1 nodded cuttings it was observed that the callus formation was between 6.67% and 30% while in the media II and III it was 0%. In the 2 nodded cuttings the callus formation was between 6.67% and 20%. Again, no callus formation was observed in the media II or III. In the 3 nodded cuttings the callus formations were between 6.67% and 13% while there was not any callus formation in the medium II (Fig. 5.)

The highest rooting percentage (26.67%) was on 3 nodded cuttings in the medium I, followed by the media VI, V, II, IV and III, respectively. In 1 nodded cuttings there was no rooting in the media II, III and IV, while there was some rooting observed (6,67 to 20%) in the media I, V and VI. In 2 nodded cuttings, except in the medium IV, rooting was observed between 3.33 and 23.33%. In 3 nodded cuttings rooting was between 6.67 and 26.67%, except in the medium III (Fig. 6.)

The highest percentages of survival rate for both Domat cv. and Ayvalık cv. cuttings, during April 2003, were observed in the media I, V, VI, IV, II and III respectively. The highest survival rate (60%) was observed on the medium I in the 3 nodded cuttings. In the 2 and 3 nodded cuttings, for all media, it was observed the survival rate in 3.33 to 33.33% and 6.67 to 60%. 1 nodded cuttings showed survival rate only in the media I, IV, V, VI and III (Fig. 7.).

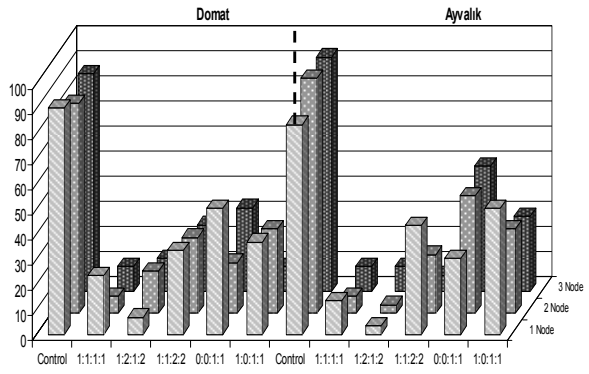

Figure 1. Survival rate of Domat cv. and Ayvalık cv. cuttings in December 2002.

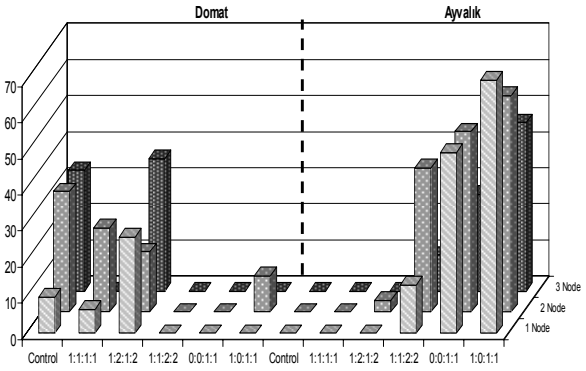

Figure 2. Callus percentage of Domat cv. and Ayvalık cv. cuttings in February 2003.

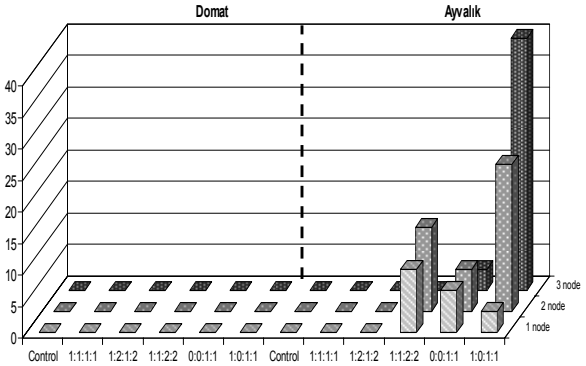

Figure 3. Rooting percentage of Domat cv. and Ayvalık cv. cuttings in February 2003.

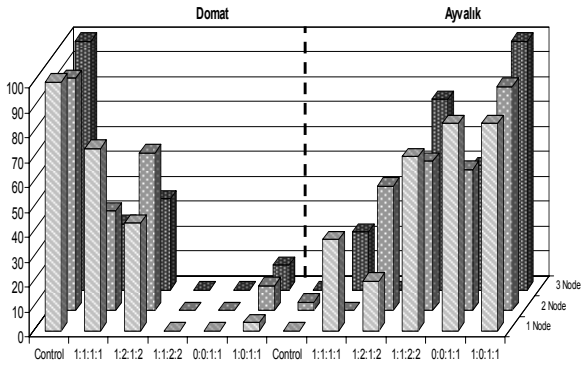

Figure 4. Survival rate of Domat cv. and Ayvalık cv. cuttings in February 2003.

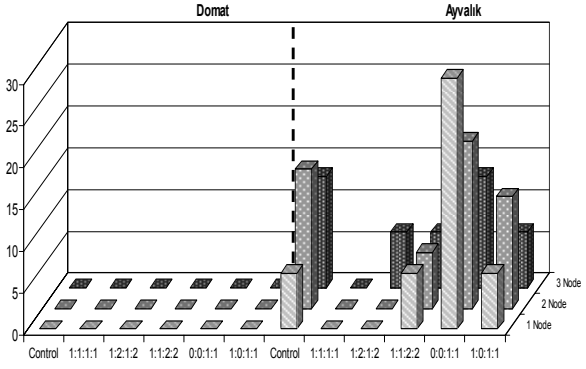

Figure 5. Callus percentage of Domat cv. and Ayvalık cv. cuttings in April 2003.

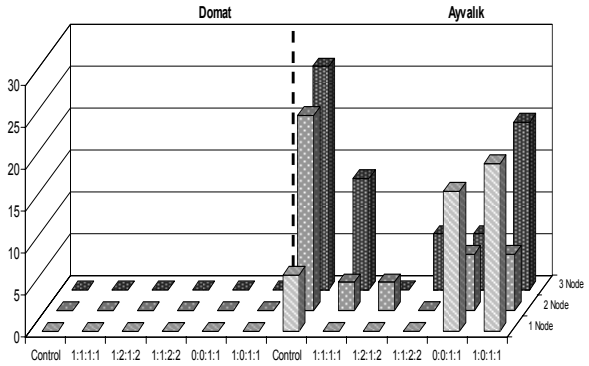

Figure 6. Rooting percentage of Domat cv. and Ayvalık cv. cuttings in April 2003.

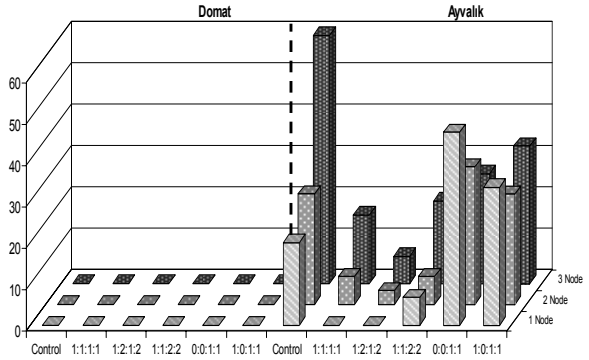

Figure 7. Survival rate percentage of Domat cv. and Ayvalık cv. cuttings in April 2003.

Discussion and Conclusions

Due to the low percentage of rooting in various species and varieties of olive, different kind of vegetative propagation methods were used. In the easy-to-root varieties generally cuttings are used, while for some other varieties, which are difficult to root, grafting methods are used. Propagation by cuttings is fast, easy and the most economic vegetative propagation method. In order to improve root formation, mist propagation is generally used and cuttings are placed in a closed cabin or tunnel, and are kept under high humidity in order for them to form roots (Ozkaya 1997).

In order to maximize the ability of cuttings to produce roots; A- They must be kept under optimum humidity and temperature; B- Perlite and sand are media specially used for mist propagation methods. In these media, special care must be taken to properly facilitate the drainage of extra water in order to achieve the optimum humidity ratio. C- In conditions of 80%-90% humidity and 20^{o}-30^{o}C temperature, approximately after 45-60 days the formation of roots has appeared in the cuttings. During the acclimatization period after they have been transferred to another media, special care must be taken because there is a high percentage of nursery plants that usually die in this period.

The above fore-mentioned issues are the most common problems in the production of nursery plants. Most of the experiments are about the decrease of dead cuttings during the rooting formation. There has not been a lot of research during the acclimatization phase. However, with proper research during the acclimatization phase it can be achieved much higher percentages of successful rooting while at the same time minimizing the labor power needed.

The existence of some rooting media (ex. sand/silt ratio) affects not only the survival rate of cuttings but also the formation of rooting and callus. Usually silt is being used as acclimatization media but we have to develop another medium that will server both as rooting media and acclimatization media. Therefore different media were examined for their ability to both improve the rooting formation and to obtain ready to sale nursery plants. The selection of media and the combination of rooting media were kept to a minimum after consulting and taking into the consideration the opinion of various specialists and professionals in the area of vegetative propagation. From this research we determined that if the ratio of sand to silt is bigger then there is a decrease in the survival rate of cuttings.

Some of the cuttings didn't develop neither roots nor callus and still remained alive. By using survival rate, it can be decided that the medium can not be the appropriate medium for optimum rooting. Rooting observed only in the cuttings of February 2003 and April 2003 seasons. In this situation we evaluated callus and rooting percentage only. The Ayvalık cv., being easy to root, formed both callus and rooting, while the Domat cv., being difficult to root, formed only callus. In Ayvalık cv., the highest callus formation (70%) was observed on cuttings of 1 node taken in May in 1:0:1:1 rooting media and the highest rooting (40%) was observed on cuttings of 3 nodes in the same date and media. In Domat cv., the highest callus formation (36.67%) was observer on cuttings of 3 nodes taken in May in 1:2:1:2 rooting media.

Ozkaya and Celik, (1993) and Celik et al, 1993 got successful rooting especially for difficult to root, under similar rooting environments with the use of SPT. However in this research Ayvalık cv., being easy to root, had difficulties formatting roots, even in SPT. This situation shows that the rooting media combination of Perlit: Peat: Sand: Silt medium did not encourage formation of root. As a consequence, the combination of rooting formation and acclimatization media has to be researched in more detail in order to find the most optimum rooting media. In some periods, it was observed that under the SPT the cuttings spoiled. This condition shows that the usage of the SPT method, instead of the mist propagation method, in Edremit has to be used more carefully.

Cutting size is one of the most important points of this research. Usually the cuttings have 3 to 4 nodes, but in this research in order to produce more cuttings from the mother plant, and at the same time increase the probability of some cuttings to survive, the cuttings which have 1, 2 and 3 nodes used. The results showed differences between 1 and 2 and 3 nodded cuttings. Nevertheless, through this research, though not

conclusively proved, all size of cuttings can be used, to various degrees, for successful root formation.

In conclusion, the use of SPT is a method to have successful root formation, especially if there is no modern mist (real foggy) propagation system. The aim of this research was to avoid the acclimatization phase, so it was observed that it needs some more research for details, in order to get success. Therefore, choosing the optimum rooting media becomes very important. To encourage rooting, choose the optimum medium combination. For example, a silt and sand medium gave good results in most cases. While the chosen media will help the cuttings to root, it should also serve as the growing media. To increase the probability of successful cuttings survival, use the minimum number of nodded cuttings. This research has shown very similar survival ratios on 1, 2 or 3 nodded cuttings. But in order to reach a conclusive decision more detailed researches should be done in the future. Focus should be placed in deciding the appropriate cutting size, for economical usage of stock material, and on rooting media and rooting treatment.

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