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Araştırma Makalesi / Research Article

Determination of Rooting Rates of Rootstock Hazelnut (*Corylus colurna* L.) Genotypes in Wood Cuttings

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Abstract

The research was conducted in Tosya district of Kastamonu province between 2020 and 2022 with the objective of ascertaining the rooting of rootstock *Corylus colurna* L. genotypes. The study utilized one-year-old cuttings, meticulously planned in three replicates, with 20 cuttings employed in each replicate. The doses of indole-3-butyric acid (IBA) employed for rooting ranged from 0 to 6000 ppm, with specific concentrations including 0, 500, 1000, 2000, 3000, 4000, 5000 and 6000 ppm. Two-thirds of the IBA-treated cuttings were then buried in pans containing a perlite, and rooting was induced. The traits of the survival rate (%), callusing and rooting rate (%), as well as rooting (quantity), roots (cm) and shoots length (cm) and the number of leaves (quantity), were examined. The study revealed that the highest rooting rate was observed in the 5000 ppm treatment, reaching 25%, while the lowest rate was recorded in the control, at 1.7%. The 1000 ppm treatment resulted in the highest number of roots (8%), followed by the 2000 ppm treatment, which produced 6.3%. Following a thorough evaluation of the study's findings, it is recommended that 5000 ppm IBA be applied for the purpose of rooting in wood cuttings.

Keywords: Cutting, Rooting, Perlite, Turkish hazelnut.

Anaçlık Fındık (*Corylus colurna* L.) Genotiplerinin Odun Çeliklerinde Köklenme Oranının Belirlenmesi

Öz

Araştırma Kastamonu ili Tosya ilçesinde seleksiyon ıslahı yoluyla seçilen anaçlık *Corylus colurn*a L. genotiplerinin köklenme oranlarının tespit edilmesi amacıyla 2020-2022 yılları arasında yürütülmüştür. Çalışma, bir yaşlı odun çelikleri ile üç tekerrürlü olarak ve her tekerrürde 20 çelik temsil edecek şekilde planlanmıştır. Köklendirmede indol butirik asidin (IBA) 0, 500, 1000, 2000, 3000, 4000, 5000 ve 6000 ppm dozları uygulanmıştır. IBA uygulanmış çelikler köklendirme ortamı tavalarına 2/3'ü gömülerek köklenmeye alınmıştır. Çeliklerde, canlı çelik (%), kallüs oluşumu (%) ve köklenme oranı (%), kök sayısı (adet), kök (cm) ve sürgün uzunluğu (cm) ve yaprak sayısı (adet) özellikleri incelenmiştir. Çalışma sonucunda en yüksek köklenme oranı %25 ile 5000 ppm uygulamasında elde edilirken en düşük köklenme oranı kontrol uygulamasında (%1.7) görülmüştür. En yüksek kök sayısı ise %8 ile 1000 ppm uygulamasında tespit edilirken, bunu %6.3 ile 2000 ppm dozu takip etmiştir. Çalışma sonucunda elde edilen bütün değişkenlere ait veriler değerlendirildiğinde 5000 ppm IBA uygulamasının Türk fındığı odun çeliklerinde köklenme için önerilebilir kanaati oluşmuştur.

Anahtar Kelimeler: Çelik, Köklenme, Perlit, Türk fındığı.

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1. Introduction

Türkiye has well-established tradition of fruit cultivation, and recently, there have been significant improvements in fruit sapling production. The current production of fruit and vineyard saplings in Türkiye at 238 million. Notably, there is an absence of records pertaining to hazelnut sapling production. A study conducted to ascertain the procurement sources of hazelnut seedlings revealed that all (100%) of the seedlings utilized in new orchard facilities are derived from bottom shoots. Producers prioritise bottom shoots that can be saplings, selecting those that are abundant, productive, and healthy. It has been documented that 59.58% of the seedlings utilized in the establishment of orchards were sourced from the producers' personal gardens, 27.92% were obtained from other orchards in the vicinity, 8.17% were acquired from outside the province, and 3.50% were obtained from agricultural organizations (İslam et al., 2019).

Corylus avellana L. is typically propagated through vegetative methods, though it has been observed to facilitate the transmission of diseases (Scortichini, 2002). Micropropagation techniques have been extensively employed for the purpose of generating disease-free seedlings (Sgueglia et al., 2019; Braun and Donald, 2019).

In hazelnut cultivation, the most straightforward method for producing seedlings is through the use of bottom shoots. The seedlings obtained through this method should exhibit a smooth and disease-free appearance, devoid of new shoots from the bottom. The ideal seedlings should be 1-2 years old, with abundant root growth and undamaged health. When selecting seedlings for use in establishing a new orchard, even when attention is paid to selecting those from well-developed and abundant productive sources, hazelnut seedlings are generally weak-rooted.

In Türkiye, hazelnut cultivation is predominantly undertaken in gardens established by the so-called hearth method. In contrast, in countries such as the USA, Spain and Chile, single-stem cultivation is the preferred approach (Karatas et al., 2018). In some countries, Dundee, Newberg, Gasaway rootstocks obtained from *Corylus colurna*, which do not produce bottom shoots, are used. Saplings obtained by the top-dipping method are used in new garden establishment (Karatas et al. 2018). A substantial body of research has been dedicated to the study of rootstock and seedling production in hazelnut (Lagerstedt, 1976 and 1993; Gautam and Howard, 1994; Yu and Reed, 1995; Korac et al., 1997; Bassil et al., 1991; Damiano et al., 2005; Roversi, 2015). However, there is a paucity of research focusing on the characteristics of hazelnut rootstock (İslam et al., 2023). Consequently, there is a necessity to augment the existing body of knowledge in this area and to undertake further studies in this field.

Kantarcı and Ayfer (1992) reported that high-dose IBA (5000 ppm) application increased the rooting rate in a study on *Corylus avellana* L. species. In numerous studies where IBA application was conducted, the timing of cuttings alongside the chemical application was examined, revealing that IBA application significantly augmented the number of roots and their quality, irrespective of the date of cuttings (Kantarcı and Ayfer 1992). Hartmann and Kester (1990) further emphasized the efficacy of high concentrations for successful hazelnut propagation through wood cuttings. Ercişli and Read (2001) obtained high rooting at 2000 ppm IBA dose in their rooting studies with soft and semi-woody cuttings of hazelnut (*Corylus colurna*). İslam et al. (2019) reported that 4000 and 8000 ppm IBA doses can be recommended for rooting of *Corylus colurna* L. wood cuttings.

The process of fruit cultivation commences with the production of saplings, which must be authentic, robust, and adhere to established standards (İslam et al., 2019). Vegetative propagation methods are predominantly employed in nursery settings. However, research on rootstock breeding in hazelnut is currently limited. Furthermore, studies that ascertain rootstock characteristics are inadequate. Consequently, there is a pressing need for research focusing on rootstock breeding and vegetative propagation in hazelnut. The present study was conducted with the objective of determining the rooting characteristics of rootstock *Corylus colurna* L. genotypes identified by selection breeding from Küçüksekiler village in Tosya of Kastamonu province. It is anticipated that the data obtained will contribute to the development of improved rootstock, rooting, and, in particular, the hazelnut sector.

2. Materials and Methods

2.1. Materials

The cutting materials were gathered from Küçüksekiler village in Tosya of Kastamonu province between 2020 and 2022 (March; Figure 1). Following the evaluation, cuttings were taken from one-year-old shoots of the genotypes with prominent rootstock characteristics and stored in the refrigerator at +4°C temperature and 65% humidity until the rooting process.

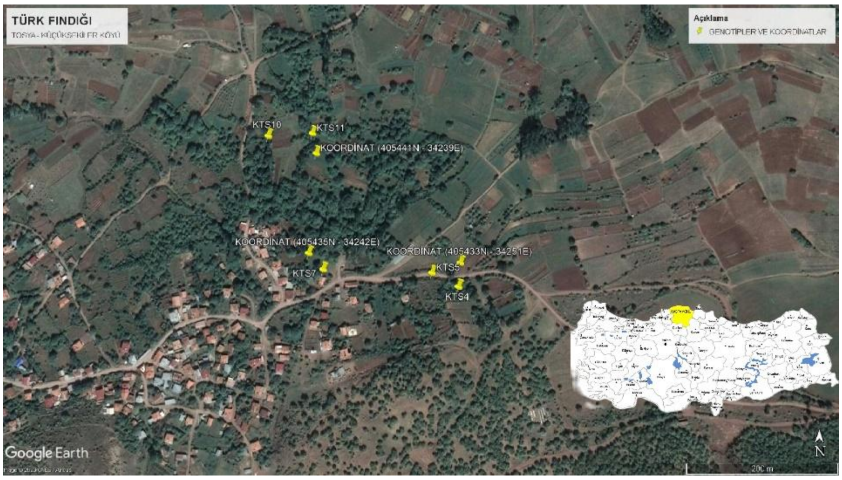

Figure 1. The geographical location in which the samples were obtained

2.2. Methods

The experiment was conducted within a rooting tray situated in the plastic greenhouse at Ordu University Faculty of Agriculture application area. The study utilized indole-3-butyric acid (IBA) doses ranging from 0 to 6000 ppm; encompassing 0, 500, 1000, 2000, 2000, 3000, 4000, 5000 and 6000 ppm, respectively. In the study, which was carried out in three replicates, 20 cutting were used in each replicate. The cuttings were immersed in IBA solutions for a period of 5-6 seconds (Hartman and Kestel, 2002). Thereafter, two-thirds of the cuttings were buried in perlite rooting medium and the process of rooting was initiated (Figure 2).

Figure 2. Preparation of cuttings (A) and rooting in perlite condition (B)

A rooting condition of agricultural perlite was utilized in the experimental setup. The rooting process was conducted in thermostatically controlled rooting pans that were bottom-heated to a temperature of +24°C within a high tunnel environment. The application of misting was employed to mitigate moisture loss. After a period of 90 days, the cuttings were removed from the rooting condition, and the following parameters were determined: Viable cutting (%; SR), callus formation (%; C), rooting rate (%; RR), number of root (quantity; RT), root length (cm; RL), shoot length (cm; SL) and number of leaves (quantity; LV; İslam et al., 2023).

2.3. Statistical analysis

The study was conducted in a randomised plots experimental design, with three replicates, and the data were analysed with JMP 13.0 (a business unit of SAS for Windows) statistical package programme at 5% significance level.

3. Findings and Discussion

In general, it can be said that the rooting rate increases with the increase in IBA doses and high IBA doses are more effective in the rapid dipping process (Çiçek and Özel, 2021). Of course, this may vary according to the time of taking cuttings, the type of cuttings and the dose intensity of the plant growth regulator applied. Namely; the higher rooting rate of the bottom cuttings may be due to the fact that the bottom parts of the shoots are rich in carbohydrates and this encourages root development (Hartmann et al., 2011). In our study, the cuttings were removed 90 days after the establishment of the experiment and measurements and observations were made (Figure 3).

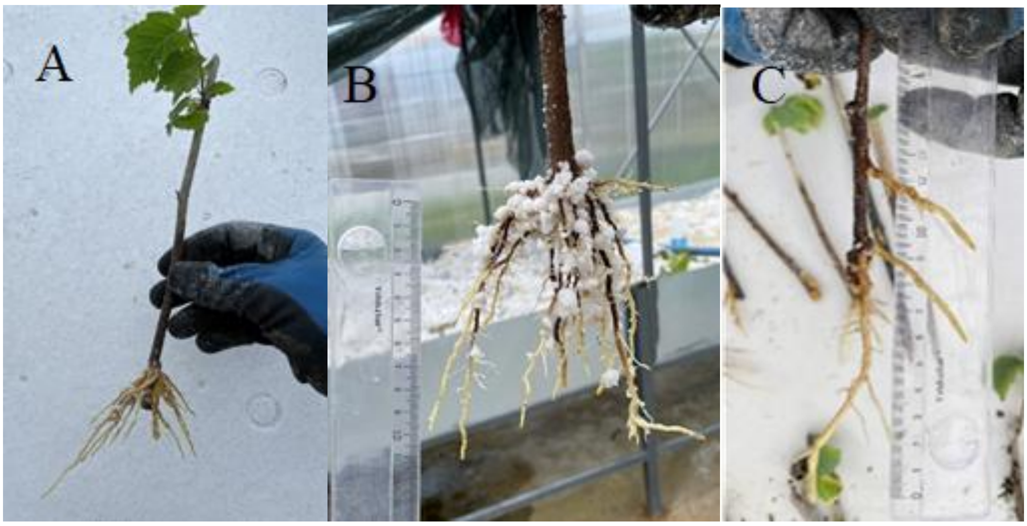

Figure 3. Rooting of wood cuttings with different IBA applications (A-C)

The measurements demonstrated that the highest survival rate was recorded in the control group, which accounted for 60% of the total (Figure 4). This was followed by 1000 ppm IBA with 48.3%, 3000 ppm IBA with 46.7%, 2000-4000 ppm IBA with 43.3%, 6000 ppm IBA with 40% and 500 ppm IBA with 30%. The lowest number of viable cuttings was observed in the 5000 ppm IBA treatment, yielding 28.3%. The highest number of callus-forming cuttings was observed in the control group, with 26.7% of cuttings forming callus. This was followed by the 1000 ppm IBA group, with 20% of cuttings forming callus, and the 4000 ppm IBA group, with 16.7% of cuttings forming callus. The 3000 ppm IBA group had the lowest number of callus-forming cuttings, with only 3.3% of cuttings forming callus. The least callus formation was detected in the 500 ppm IBA treatment, with a percentage of 1.7% (Figure 4).

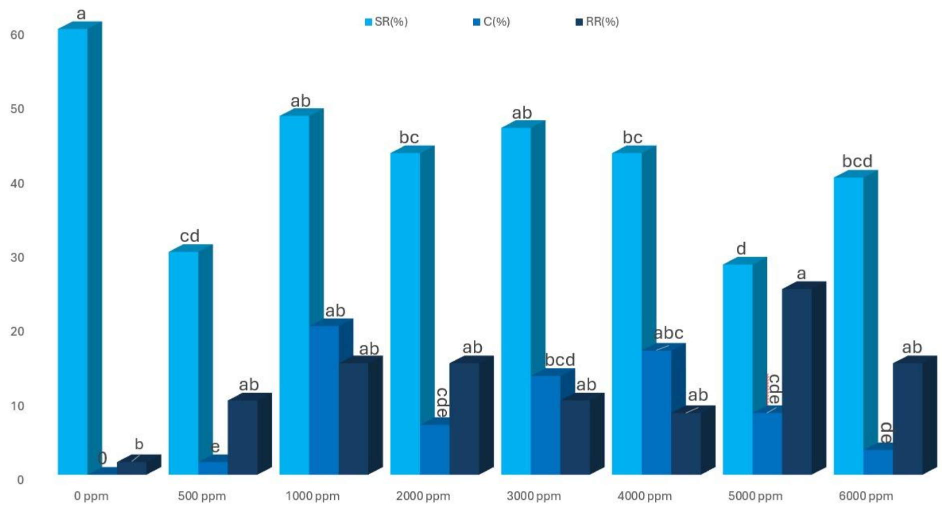

Figure 4. Effect of IBA concentration (0-6000 ppm) on survival rate (SR), callusing (C) and rooting rate (RR**).** Data represent the mean ± sd (n=3). Different letters indicate significant differences ($p<0.05$).

The treatment with 5000 ppm IBA produced the highest rooting rate, with 25% of the cuttings successfully rooting. This was followed by the 1000 ppm, 2000 ppm, and 6000 ppm IBA treatments, each yielding around 15% rooting. In comparison, the 500 ppm and 3000 ppm IBA treatments resulted in 10% rooting, while the 4000 ppm IBA treatment showed the lowest rooting rate at 8.3%, as shown in Figure 4. İslam et al. (2023) reported that the number of viable cuttings was obtained from IBA 4000 ppm dose and the rooting rate was 21.7% in the same application. Conversely, Srivastava et al. (2010) reported that a 33% rooting rate was achieved at a 3000 ppm dose, and Hartmann and Kester (1990) recommended high IBA doses for hazelnut propagation by wood cuttings.

The highest mean number of roots in the rooted cuttings was observed in the 1000 ppm IBA treatment, which had eight pieces. This was followed by the 2000 ppm IBA treatment, which had six pieces, and the 5000 ppm IBA treatment, which had five pieces. The 3000-6000 ppm IBA treatment had an average of four pieces. The lowest average number of roots in the rooted cuttings was found in the control group with 0.60 (Figure 5). The highest number of leaves was observed in the control group, with a mean of 7.7, followed by 6000 ppm IBA, with a mean of 7.3, 1000-3000-4000-5000 ppm IBA, with a mean of 6.3, and 2000 ppm IBA, with a mean of 5.7. The lowest number of leaves was found in the 500 ppm IBA treatment, with a mean of 5.0 (Figure 5). İslam et al. (2023) reported that the number of roots per rooting plant was significantly higher than the other doses in cuttings treated with 8000 ppm IBA, exceeding 6000 ppm. In addition to these findings, Kantarcı and Ayfer (1992) reported that high doses of IBA (5000 ppm) increased the rooting rate in *C. avellana*, Erdoğan and Smith (2005) reported that the average number of roots increased in parallel with the increase in dose.

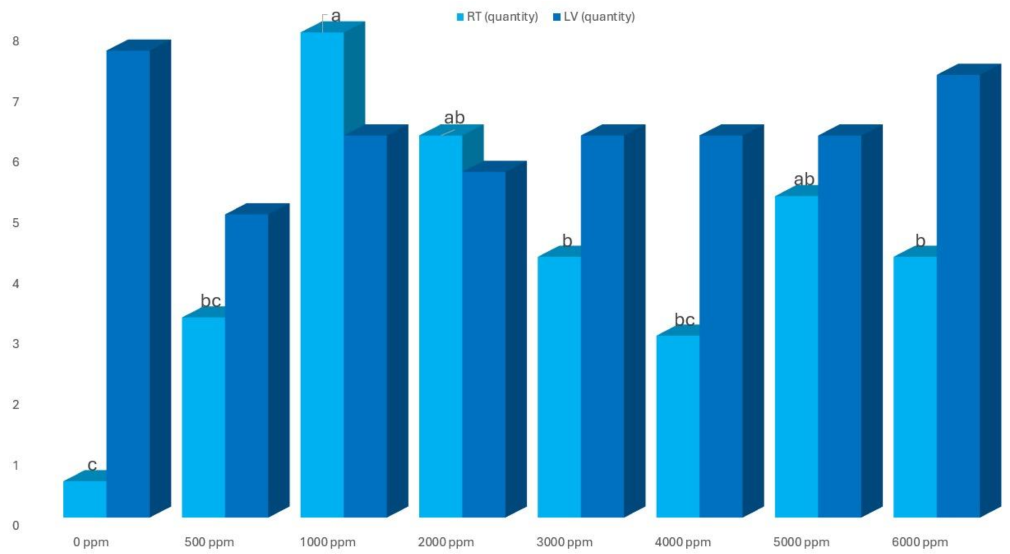

Figure 5. Effect of IBA concentration (0-6000 ppm) on rooting (RT), and number of leaves (LV)**.** Data represent the mean ± sd (n=3). Different letters indicate significant differences ($p<0.05$).

The maximum root length was obtained from the 1000 ppm IBA treatment, which yielded a measurement of 14.3 cm. This was followed by the 5000 ppm IBA treatment, which yielded a measurement of 10.7 cm, the 2000 ppm IBA treatment, which yielded a measurement of 9 cm, and the 0 ppm IBA treatment, which yielded a measurement of 2 cm. The least root length was measured in the control group, which was 0.3 cm (Figure 6). The mean shoot length was recorded as 9.7 cm in the control group, followed by 8 cm in the 6000 ppm IBA group, 6.3 cm in the 5000 ppm IBA group, 6 cm in the 500 ppm IBA group, and 5.7 cm in the 3000-4000 ppm IBA group.

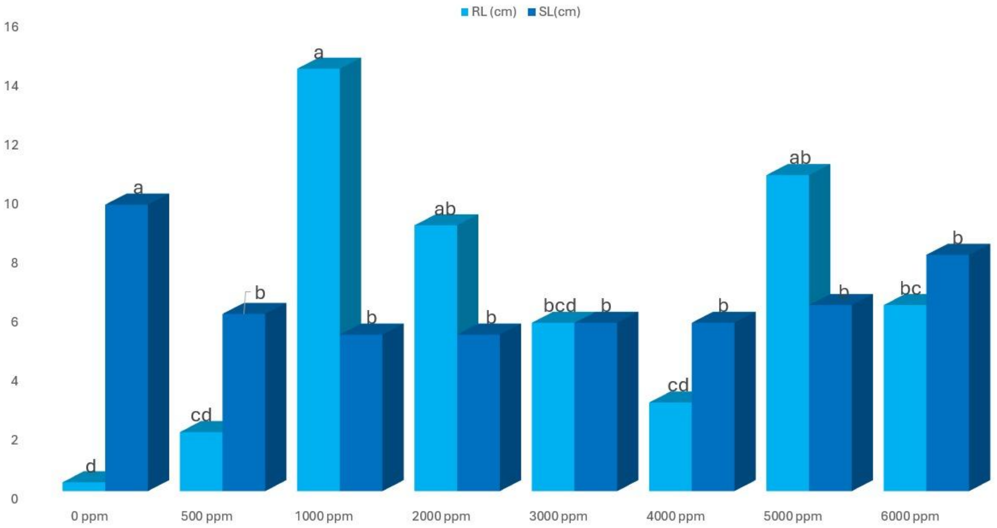

Figure 6. Effect of IBA concentration (0-6000 ppm) on roots and shoots length**.** Data represent the mean ± sd (n=3). Different letters indicate significant differences (p<0.05).

The shortest shoot length was observed in the 1000-2000 ppm IBA treatments, with an average of 5.3 cm (Figure 6). In a related study, Avcı (2023) reported that the rooting rate, the proportion of live cuttings, and the root length of the cuttings of the Tombul cultivar varied depending on the time of taking the cuttings and the treatments. Furthermore, it was observed that the most successful results were obtained in the 15 June-2000 ppm IBA treatment, and it was emphasized that the number of roots per cuttings and rooting level were in the 10 July-2000 ppm IBA treatment. Consequently, the study by Sayar (2023) on the Foşa cultivar also highlighted the significance of the timing of cuttings in terms of rooting and other characteristics. In a similar vein, Cristofori et al. (2010) ascertained that the rooting rate of green cuttings taken in June ranged from 0-50%, the callusing rate varied from 0-70%, and the number of roots was 0-4.7. The rooting rate of semi-wood cuttings taken in July was found to be 0- 26.7%, callusing rate was 0-46.7% and number of roots was 0-11; rooting rate of semi-wood cuttings taken in August was 0-76.7%, callusing rate was 0-63.3% and number of roots was 0-6.3. In addition, it was observed that these characteristics varied according to the cultivars.

Consequently, it was observed in our and previous studies that the time of cuttings and the concentration of IBA applied had different effects on the characteristics of viable cuttings, callus formation, and rooting rate, number of roots, root and shoot length and number of leaves. Furthermore, ambient humidity and natural auxin content in the cuttings have been reported to be influenced by callus formation (Baul et al., 2010). In addition to these findings, it is widely acknowledged that cultivar and genetic differences, the location of the cuttings, nutritional status, storage conditions and period will also vary in terms of these characteristics.

4. Conclusions and Recommendations

In the field of hazelnut rootstock breeding, which has a long cultural history, studies are extremely limited. Therefore, further research in this area is imperative. The present study investigates the effects of different IBA doses on rooting rate and other root parameters in wood cuttings of various *Corylus colurna* genotypes. The results demonstrate variability in the effects of the doses applied. While other studies have examined the rooting success of diverse *Corylus colurna* genotypes in hazelnut, the addition of new comparative studies remains essential to the scientific community. A comprehensive evaluation of the data revealed that the application of 5000 ppm IBA was moderately effective in promoting rooting in *Corylus colurna* cuttings. Consequently, it is anticipated that the continuation of these studies will significantly contribute to the hazelnut production sector.

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Authors' Contributions

All authors contributed equally to the study.

Statement of Conflicts of Interest

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

The author declares that this study complies with Research and Publication Ethics.

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