Prospects of hazelnut (*Corylus Avellana* L.) growing in Uzbekistan

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Abstract. The manuscript presents a comprehensive investigation into the propagation of hazelnut (*Corylus*) using semi-hardwood cuttings, with a particular emphasis on exploring various planting schemes to identify the most optimal approach. In an era where sustainable and efficient methods of horticultural propagation are crucial, this study contributes valuable insights to enhance hazelnut cultivation practices. The experimental trials were meticulously designed and executed during the final ten days of May, a crucial period that aligns with optimal growth conditions for hazelnut cuttings. A key innovation in this research was the utilization of a specialized fog-generating facility. With the overarching goal of determining the most advantageous planting scheme, a range of configurations was employed. Factors such as spacing, arrangement, and density were meticulously varied, allowing for a comprehensive assessment of their impact on hazelnut seedling growth. This systematic approach aimed to identify the scheme that maximizes the use of available space while ensuring optimal development and survival rates of the seedlings. The outcomes of this research represent a significant achievement in hazelnut propagation. Notably, the study demonstrated the successful cultivation of high-quality seedlings, achieving an impressive count of 42 to 45 seedlings per square meter of cultivated area. This achievement underscores the potential for efficient and productive propagation using the semi-wooden cuttings method. Furthermore, it highlights the critical role that suitable planting schemes play in harnessing the full potential of this propagation technique.

Keywords. Hazelnut, *Corylus*, tree, leaf, planting scheme, substrate, biohumus, regeneration.

1 Introduction

Corylus is a tree belonging to the birch family; a genus of deciduous shrubs. 20 species are known in the forest zones of Europe, Asia and North America. Hazelnut belongs to *Corylus* genus, *Birches* belong to *Betulaceae* family, and 10 species are found in CIS flora in different geographical conditions [1].

A common species is the hazelnut (*C. avellana*). In the Far East, Manchurian Leschina (*C. mandshurica*), different-leaved Leshchina (*C. heterophylla*) can be found. In the Caucasus, in addition to the common type, tree Leshchina, Colchida Leshchina (*C. colchica*)

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and Pontic Leshchina (*C. pontica*) species grow [2]. In the Caucasus and the Crimea, a large hazelnut or Lombard nut (*C. maxima*) is grown. Ihota forests will be built from Leshchina. The height is up to 2-5 m (sometimes 8 m). The flower is bisexual; the male ones are collected in a cluster, and the female ones are collected in a two-flowered bouquet. The fruit is a one-celled, one-nut nut [3]. It grows well in wet and fertile soils, especially in dark forests and black soils. Needs heat and humidity. The tree will bear fruit 5-6 years after planting. Up to 8 kg of nuts are obtained from one bush. Nuts contain 60-70% oil. It is propagated by cuttings from walnuts and bachki branches. Lives more than 80 years [4].

Hazelnut is a typical shrub, only some species form a tree-like form. This plant has some unisexual flowers, the stamens and stamens are located on the same branch, the stamens hang like a long earring and bloom in early spring until the leaves emerge. The arrangement of the flowers is usually simple, separated in four piles, the anthers are hairy-large (0.9-1.2x0.6 mm) and the tip of the anther is like two scythes, arranged in 8. Sawn grain (20 μm) is in the form of granules, smooth [5]. The flower is surrounded by three petals. Changchi flower buds appear in autumn, overwinter and bloom in spring. There are from one to four stamens in one panicle. Their length is from 8 mm to 35 mm, and they are cylindrical, inverted ovoid, straight, bent, rounded at the top, sharp or obtuse [6].

At the moment, there are urgent tasks before the plantation farms and homestead land owners, such as increasing the range of seedlings, increasing the volume of cultivated seedlings and reducing their cost. In the Republic of Uzbekistan, where the field of horticulture is developing, measures to master intensive types of perennial crops and advanced methods of crop care are gaining importance [7].

In order to ensure the implementation of these tasks, it is necessary to further improve the methods of increasing crop materials and methods of cultivation based on the biological characteristics of species and varieties, soil-climatic conditions of the regions, economic requirements and issues of improving production [8].

According to scientists, many factors (planting scheme, duration, state of the stem from which cuttings are taken and its part prepared for cuttings, growing substances and their concentration) affect their rooting ability when growing fruit plants from green cuttings [9]. Among these factors, the planting scheme of green cuttings is also important. Because excessive compaction leads to rotting of cuttings due to increased humidity and shading, on the contrary, increasing the distance reduces the number of seedlings per unit area [10].

Many foreign [1, 8] and local [2-6] scientists emphasized that the planting scheme is highly important in the propagation of fruit plants from green cuttings. However, the work of these scientists is on grafts of fruit plants, vines, olives, kiwi and other plants, whose biological properties are fundamentally different from those of the hazelnut plant. Therefore, choosing a planting scheme suitable for the biological characteristics of this plant when propagating the hazelnut plant from green cuttings is an important factor in ensuring the speed of its regeneration. Activation of cambium activity is observed in the basal part of the leaf during rooting of green cuttings of hazelnut plants. This, in turn, leads to the formation of callus tissue and young regenerative xylem in this zone.

2 Materials and methods

Walnut flowers are located in several small buds. They can be distinguished from the vegetative bud by its thickness and by the protuberance with a reddish blunt end (similar to a pig's snout). The buds are covered with many coins, usually there are no flowers on the lower ones, and the flowers are placed in pairs on the upper buds. Each flower bud is covered with flesh and consists of two beaks. One nut develops in one flower - the nut is monocotyledonous. Nut meat is woody to varying degrees [3].

The leaves are simple, wide, oval, often asymmetrical, unevenly distributed enlarged teeth, long pinnate, irregularly heart-shaped in the middle, sharp near the stem. The toothed, glabrous leaf is arranged in a thin hairy band (the upper part of the leaf plate is dark), the leaves are double-rowed, shedding. The edges of the leaves are also hairy, even at the tips of the teeth, this feathery hairiness is characteristic of hazelnuts. The shape and surface area of the leaf varies depending on the width of the leaf and its location on the stem. In the lower part, the leaves are small, round and oval with a blunt tip (5-10 cm^2); the largest leaves (100-300 cm2) are located in the middle, broadly inverted ovate and sharply pointed. In the upper part, it is round, egg-shaped, and the tip is slightly pointed [4].

It can be seen from the data of Figure 1 that the country of Turkey produced 600,000 tons of hazelnut products in 2010, and after 5 years, the production volume increased and produced an additional 46,000 tons of products. It is the leading country with the production of more than 19,000 tons of hazelnuts. The next place is Italy with 140,600 tons of products grown in 2020, followed by the United States of America with 64,400 tons. The Republic of Azerbaijan produced 29500 tons of hazelnuts in 2010, 32300 tons in 2015, and 49500 tons in 2020. Uzbekistan produced 1100 tons of hazelnuts in 2010, 4000 tons in 2015, and 3700 tons in 2015 [9].

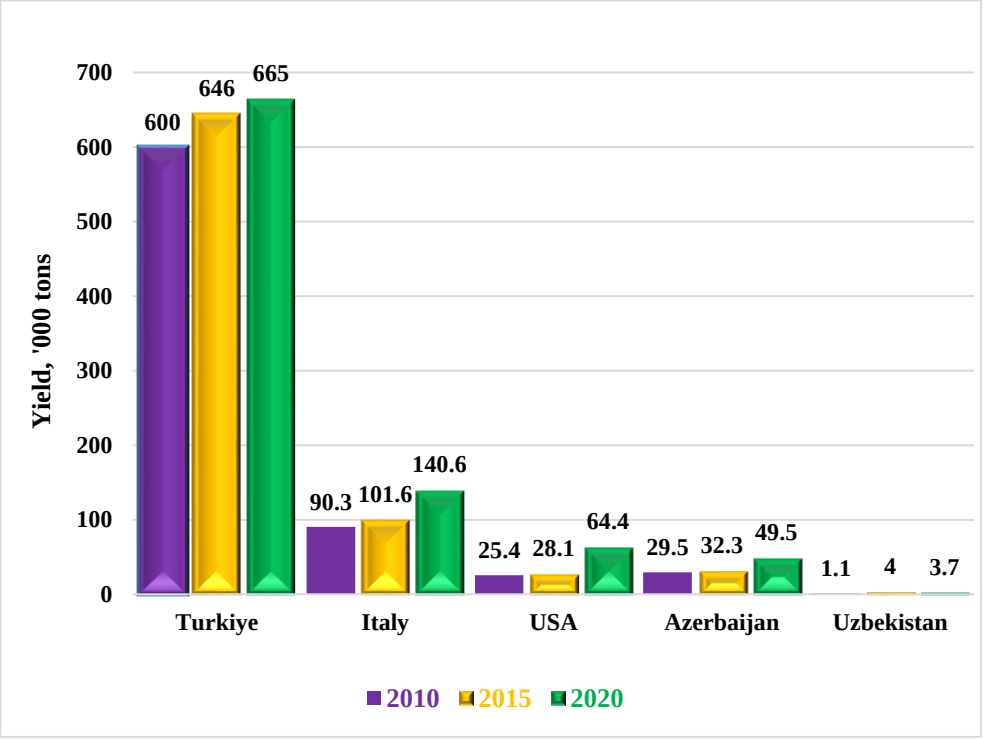

Figure 1. Hazelnut cultivation on the example of countries.

The experiment was conducted according to Ermakov's method [8]. Preparation of cuttings from hazelnut mother bushes In the third ten days of May, the experimental scheme is as follows: a microclimate controlled structure was planted from green semi-wooden cuttings in a scheme of 10x5 cm, 10x10 cm, 10x15, 10x20 cm, 10x25, 15x15 cm, 15x20 cm, and 15x25 cm. In addition, in a special substrate, the upper surface of the substrate is 8 cm of pure large-particle sand, and its lower part is planted in biohumus, which is 5 cm thick.

3 Results and discussion

Among the vegetative propagation methods, the main focus has been on the development of the technology of propagating hazelnut plants by cuttings taken from non-lignified branches with developing leaves, known in horticulture as green cuttings.

The regeneration of the green cuttings of fruit and ornamental plants is based on the process of new formation with the help of additional root and branch structural elements that stimulate the role of leaves. In the process of rooting, the leaves deliver plastic substances and hormones in the form of complex organic compounds to the shoot, and they correlate the interaction between the separate parts of the shoot. The presence of leaves in the cutting is a factor that stimulates regeneration.

When propagating hazelnuts from walnuts, it can be observed that biological signs and characteristics of the mother plant deteriorate in offspring grown from walnuts. In addition, plants grown from walnuts enter the harvest late, that is, at the age of 7-9 years. That is why hazelnut is propagated vegetatively in production conditions. When propagated in this way, the plantations begin to harvest in 4-5 years after planting seedlings. An important economic-biological feature of nut plants, especially hazelnut, is the ease of transportation of the product, the ease of keeping its nuts intact in simple facilities, and the long shelf life. This makes it possible to take care of hazel even in areas with poor roads.

The experiments on propagation of the hazelnut plant from green cuttings in different planting schemes showed that the rooting ability of green cuttings differed according to the variants. As the planting pattern expanded, the rooting capacity of cuttings increased. In accordance with the rule, the highest rooting capacity was recorded in the variant planted in the 15x25 cm scheme. In this option, the number of rooted cuttings compared to the total number of planted cuttings reached 90.4%. The least rooting was observed in the 10x5 scheme. In this experimental variant, the degree of rooting of green cuttings of the hazelnut plant did not exceed 78.32% (Figure 2).

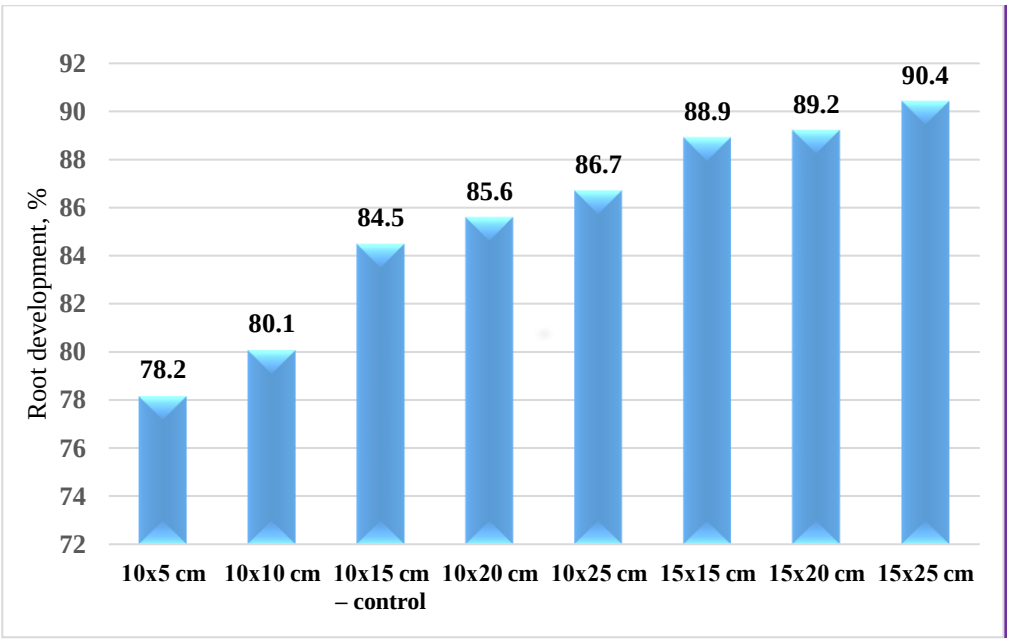

Figure 2. Green cuttings rooting of the Akademician Yablokov variety of hazelnut in different planting schemes (2021-2023).

It should be noted that the difference between the rooting capacity in the experimental options is not so high, but the thinned cuttings showed superiority in the parameters of the development of the root system. In this case, the best developed root system was noted in the cuttings of options planted in the scheme of 10x15...25 and 15x15...25 cm.

Planting scheme also had a significant effect on the development parameters of the above-ground part in green pens. In this case, the highest value of the ability to form a branch in the planted cuttings was recorded in the variant planted in the scheme of 15x25 cm. In this option, compared to the total number of planted green cuttings, the amount of them that formed a branch reached almost 97.3%. As the planting pattern became denser, the yield of shoots decreased in direct proportion. According to the rule, the least grown cuttings were recorded in the scheme of 10x5 cm. In this experimental variant, the number of sprouts did not exceed 17.4% compared to the total number of planted green cuttings (Figure 3).

Figure 3. Hazelnut cuttings planted in a special substrate.

The rest of the variants ranked between these two variants in terms of new shoot production in green cuttings and varied between 36.1 and 96.6% of the total planted cuttings, respectively, across variants.

The number of leaves formed in plants grown from green cuttings also differed depending on shoot formation. The superiority in this biometric parameter was also noted in the variant planted in the 15x25 cm scheme. It was noted that the green cuttings planted in this scheme produced an average of 18.2 leaves, which means 12 leaves more than the control. The lowest number of leaves in rooted green cuttings was recorded in the variant where the cuttings were planted in a 10x5 cm scheme. In this scheme, 2.7 fewer (6.2) leaves were formed compared to the control option (9.5). In terms of the number of leaves produced on regenerated plants, the rest of the experimental variants were intermediate in the growth sequence between these

two variants and varied between 9.6-18.7 leaves according to the variants and 2.1-8.7 more leaves compared to the control.

Experimental data show that the scheme of planting green cuttings had a significant effect on the development of the conditional body of one-year seedlings. The same trend as the number of leaves was observed in the formation of this physiological indicator (Table 1).

Table 1. Developmental characteristics of the Akademician Yablokov variety of hazelnut grown from green cuttings in different planting schemes (2021-2023).

Experiments	Root system volume, cm^3	Cuttings formed by the stem, %	Number of leaves	Conditional body diameter, mm	Plant stem length, cm
10x5 cm	2.2	17.4	6.2	7.1	36.5
10x10 cm	4.1	36.1	8.43	9.0	41.6
10x15 cm – control	5.0	61.6	9.5	11.3	45.4
10x20 cm	5.8	91.2	11.6	13.4	60.1
10x25 cm	6.4	94.7	14.7	13.6	66.2
15x15 cm	6.8	95.8	16.9	14.1	68.3
15x20 cm	7.0	96.6	17.7	14.5	69.7
15x25 cm	7.1	97.3	18.2	15.2	72.6

Therefore, the thickest and well-developed plants were recorded in the variant planted in the 15x25 cm scheme. The stem of plants grown from green cuttings planted in this scheme reached an average diameter of 15.1 mm, which is 3.9 mm thicker than this physiological indicator of the control variant. In rooted green cuttings, the thinnest conditional body diameter was determined in the variant where the cuttings were planted in a scheme of 10x5 cm. The diameter of the conditional body of the plants grown in this experimental variant did not exceed 7.1 mm, and they were 4.2 mm thinner compared to this indicator (11.3) of the plants in the control variant.

The rest of the experimental variants in terms of the diameter of the conditioned body of the plants developed from the green cutting took an intermediate place between these variants and varied in the range of 13.4-14.5 mm according to the variants. The conditional trunk diameter of the plants of these experimental variants was 2.1-3.9 mm thicker compared to the control. In the planting schemes of 10x5 cm and 10x10 cm, compared to the control version, the diameter of the conditioned body of the plants was smaller by 7.1 and 9.0 mm.

It is known that in horticulture, the height of ready seedlings is also an important economic indicator. Measurement of the height of plant branches developed from green cuttings planted in different schemes showed that the highest branched plants were formed in the experimental variant planted in a 15x25 cm scheme. Plants grown in this experimental variant reached an average height of about 72.6 cm, which is 27.2 cm more than this physiological indicator of plants in the control variant (45.4 cm).

In the experiment, the lowest branched plants were determined in the variant where green cuttings were planted in a scheme of 10x5 cm. The height of plant shoots grown in this experimental option did not exceed 36.5 cm, and they were 8.9 cm lower than the height of plant shoots in the control option, and the 10x10 cm planting scheme was also 3.8 cm lower than the control option (45.4).

The remaining experimental variants in terms of the height of the plant shoots developed from green cuttings were intermediate between these variants and varied between 60.1-69.7 cm according to the variants. In these experimental variants, the shoot length of the formed plant was 14.7-27.2 cm longer, compared to the control variant.

It is worth noting that although the regeneration of plants occurs at a high rate when the planting scheme is thinned, it is important to choose the optimal option in terms of the amount of ready seedlings per unit of area.

Calculations showed that the yield of standard seedlings with the length of the main branch over 60 cm was the highest in the 10x20 cm and 15x15 cm planting schemes (42 and 45 units/m^2, respectively) compared to the total grown plants. In densely planted variants, although the number of plants that took root and grew was high, most of them (80-85%) were left for next year's cultivation. Because their height did not even reach 50 cm. On the contrary, in the sparsely planted variants, although about 95-98% of the plants sprouted and grew strongly, the number of seedlings was correspondingly low due to the fact that less cuttings were planted per unit area (Figure 4).

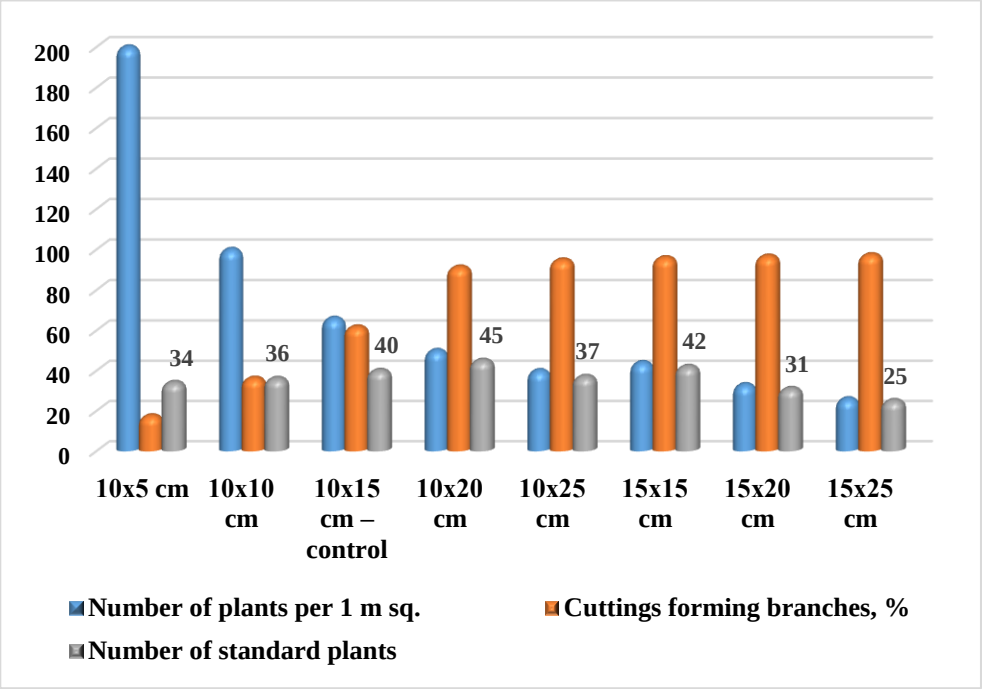

Figure 4. Effect of planting schemes on the yield of Akademician Yablokov variety seedlings of hazelnut in growing from green cuttings (2021-2023).

4 Conclusions

Based on the comprehensive analysis of the experimental findings presented above, several noteworthy conclusions can be drawn regarding the rootability and subsequent seedling yield of the Akademician Yablokov hazelnut variety. Notably, the rootability of the green cuttings exhibited a clear trend of enhancement as the spacing between the cuttings decreased. This trend culminated in a remarkable rootability rate, approaching an impressive 95%. This observation underscores the critical influence of spacing on the successful establishment of root systems in the hazelnut cuttings.

However, while the rootability rates provide valuable insights into the initial establishment of the cuttings, the ultimate goal of hazelnut cultivation lies in generating a robust and substantial yield of high-quality seedlings. In this context, it is prudent to consider

both rootability and seedling yield in conjunction to determine the most optimal planting scheme.

The experimental data reveal that for achieving optimal seedling yield per unit area, specific planting schemes warrant consideration. Specifically, the planting configurations of 15x15 cm and 10x20 cm emerged as particularly favorable options. These configurations not only facilitated the successful rooting of cuttings but also translated into a highly commendable outcome in terms of seedling yield. Remarkably, under these identified planting schemes, an impressive count of 42 to 45 high-quality seedlings of standard size can be obtained from a single unit of area, measuring 1 square meter.

This convergence of favorable rootability and subsequent seedling yield serves to guide practitioners and horticulturists in making informed decisions regarding hazelnut cultivation using green cuttings of the Akademician Yablokov variety. The harmonization of rootability, seedling yield, and planting schemes not only ensures efficient resource utilization but also presents a pathway to maximize the productive potential of hazelnut propagation.

In summation, the experimental results illuminate a symbiotic relationship between spacing, rootability, and seedling yield in the context of the Akademician Yablokov hazelnut variety. The findings underline the significance of carefully tailored planting schemes to harness the full potential of this propagation method. Ultimately, the research outcomes provide invaluable insights that can drive enhanced practices in hazelnut cultivation, yielding a considerable bounty of high-quality seedlings while paving the way for sustainable horticultural endeavors.

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