

## BIOMETRIC AND YIELD INDICATORS OF HAZEL SHRUBS DEPENDING ON PRUNING

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**Abstract.** Horticulture is one of the main production areas of the agrarian field in the direction of crop production. Fruit plants have been important for human nutrition and health since ancient times. Because of its nutritional value and economic importance, the hazel plant occupies one of the main places among fruit plants. Due to the daily increasing demand for hazel plants in the world market, the main goal facing scientists and specialists is to increase their area and productivity on a scientific basis. Based on the above, our research is related to the technology of hazel cultivation and is dedicated to a very relevant topic - the pruning of the hazel plant. The research was conducted in the village of Ashaghi Tala in the Zagatala region (Azerbaijan). The objects of the study were Ata-baba and Yaghli findig varieties of the hazel plant. One of the main goals of pruning hazel orchards is to rejuvenate old plants. The most convenient method is the gradual pruning of old stems within the shrub and replacing them with young ones. The degree of pruning varies depending on the age of the tree and the biological characteristics of the variety.

**Keywords:** hazel, pruning, biometric indicators, yield indicators.

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### 1. Introduction

One of the main goals of the successful economic policy implemented by the state in connection with the growth of various fields of crop production is to achieve the development of the non-oil sector - the agricultural sector in general. In crop production, horticulture is one of the main areas of the agrarian field. Fruit plants have been important for human nutrition and health since ancient times. The hazel plant is one of the useful fruit plants due to its nutritional value and economic importance. Increasing its planting area and productivity on a scientific basis is the main goal set by scientists and specialists because of the daily growing demand for hazel plants in the world market. For this purpose, the head of state instructed the Ministry of Agriculture to prepare a state program related to the development of hazel cultivation, and its implementation began in March 2016. In the State program, it was envisaged to increase the area of hazel orchards in the territory of the republic to 80 thousand hectares by 2020 and to increase productivity by applying innovative cultivation technologies. Seedlings of local hazel varieties and partially introduced varieties were used as planting material. According to the statistics for 2021, the area of hazel orchards in the republic is 80.4 thousand hectares. 49,000 hectares or 60.9% of these orchards are fertile trees, and 21,400 hectares (39.1%) are young orchards. Hazel is among the most cultivated plants for business purposes in Azerbaijan in recent years. 93.9% of the total hazel orchards are traditional and 6.1% are intensive orchards. According to the statistics for 2021, about 790 hectares of new hazel

orchards were planted in Azerbaijan (<https://www.agbz.ru/news/azerbaydzhan-tretiy-po-velichine-eksporter-funduka-v-mire/>).

From ancient times, people have used the products of fruit plants spontaneously. It is believed that 10,000 years ago when the last ice age ended, the hazel plant was one of the productive plants that saved our ancestors from starvation during the formation of mankind. In the works of Vergili, Theophrastus, Sophocles, and other ancient philosophers, hazelnuts are mentioned more than other productive plants.

According to the data presented by the Institute of Hazel Farming located in Trabzon, Turkey, which is the only one in the world, hazel has been known as an industrial plant for 600 years, but the forest hazel tree has been known to people since ancient times. Azerbaijan, which is at an important stage in the development of the non-oil industry, has a rich history of hazel farming, and thanks to state support, a flourishing process is observed in this field in recent years.

The hazel plant ranks first in the republic in terms of distribution areal, cultivated area, and yield among the plants, which fruit has a soft green shell - pericarp. In addition to using hazelnut kernels fresh, various confectionery products are made from it, oil is obtained, and flour that does not lose its quality for a long time is produced.

According to statistics, in the last 20 years, the demand for hazelnut products has increased 20 times in the world. Because hazelnuts are rich in protein, complex carbohydrates, and unsaturated fats, they do not contain cholesterol. 96% of the oil contained in the hazelnut kernel is composed of unsaturated acids such as oleic and linoleic acids, which are useful for humans. It has been proven by scientific studies that it is necessary to minimize the use of saturated fats in food. Because saturated fats are one of the main factors that cause cardiovascular diseases in the human body. In the United States, from the 70s of the last century to the present, the health of those who constantly use hazelnuts in their food is being studied. As a result of this study, it was found that those who use hazelnuts in their food have a 50% lower risk of heart disease than those who do not.

Although Azerbaijan ranks third in the world after Turkey and Italy in terms of hazelnut exports, the yield per hectare is much lower than the potential. Currently, an average of 1.2 tons is harvested from 1 hectare of hazel orchards in our country. This indicator is considered a very low profit for the cost of the hazel orchard.

According to statistical data, in the first quarter of 2022, Azerbaijan ranks third in terms of hazelnut exports to the world market. Last year, 67,000 tons of hazelnuts were produced in Azerbaijan and the product obtained was exported to more than 25 countries of the world. Varieties cultivated in the orchards of the majority of hazel farms are local and introduced regionalized varieties from the former USSR. Among the hazel varieties, the most widely cultivated is the local Ata-baba variety, which makes up 80-90% of the orchards in the region.

It should be noted that most of the hazel orchards in use in Azerbaijan are those planted by traditional methods during the former Soviet Union. When planting these orchards, the root growths formed in the current year were used as seedlings. In traditional orchards, 3-6 trees are planted in each hollow. The number of stems formed in one nest before the harvest period is 50-60. Trees in such orchards usually begin to bear fruit at the age of 6 and reach full productivity at the age of 16. In orchards of this type, different food areas such as 8x8 m<sup>2</sup>, 10x8 m<sup>2</sup>, and 10x10 m<sup>2</sup> are used. In traditional orchards, the number of plants per hectare is 156, and the yield per hectare is at best 1-1.5 tons/ha. A

large number of stems prevents normal lighting and ventilation within the canopy, which results in a decrease in product quality along with quantity.

In hazelnuts, pruning begins some time after harvest, around the end of October. Because the plant is dormant at this time, the period of active growth and development is complete. In other words, this means that in all aspects it is the right time for pruning. (Tuncer, 2008).

Recently, the planting material used in gardening is cultivated in special nurseries and 1 seedling is planted in each nest in the specified food areas. In such gardens, with a proper application of shaping and pruning, 8-14 stems are kept in one nest. A pre-arranged reduction in the number of stems leads to a lower cost of pruning in subsequent years. At the same time, the improvement of the lighting and ventilation of the canopy contributes to abundant and high-quality products. Regulation of the number of stems and timely cleaning of annual growths have a positive effect on the assimilation of the nutrients by the plant and the yield. As a result, in hazel orchards planted and cultivated on the basis of this technology, the plants begin to bear fruit in the 4-5th year after planting and enter the period of full productivity at the age of 9. The yield per hectare is 2.5-3.0 tons in a full crop year.

In modern intensive horticulture, farmers are interested in planting single-stem tree-shaped varieties. In intensive-type orchards with tree-shaped hazel plants, the number of plants per hectare can vary from 500 to 1000 depending on the food area. Taking into account the wider potential capabilities of these plants, it is possible to get an average of 20-25 kg of product from one tree.

Hazelnut productivity up to 20 years of age is at its maximum. As the years go by, the yield of the bush decreases. Therefore, the number of stems on the bushes should be properly regulated, trunks that are more than 20 years old should be trimmed, replaced by younger branches. The number of branches on the bush depends on the planting scheme (Ibrahimov, 2018).

According to I. Tsybenko (2019), the productivity of hazel orchards can be increased based on the following factors:

- Plants should be located in food areas of 5 x 2.5 m (800 trees/ha) or 5 x 2 m (1000 trees/ha);
- Plants should have an umbrella shape consisting of two "V"-shaped branches;
- Using the Croatian technology, espalier gardens should be planted with the number of plants per hectare being 4-5 thousand;
- The nutritional regime of plants should be determined by soil analysis;
- Fertigation should be applied based on drip irrigation and water analysis;
- Plants must be protected from diseases and pests in time;
- Regionalized varieties tested under local conditions should be planted.

The research revealed that for 1 ton of hazelnuts, the plant absorbs 10-15 kg of nitrogen, 3-4 kg of phosphorus, 7-8 kg of potassium, and a certain amount of microelements from the soil. Since hazel shrubs are cultivated for a long time in the place where they are planted, the soil fertility declines, and the productivity of the orchard gradually decreases (<https://www.neo-agriservis.ru/articles/tekhnologii-vyraschivaniya-selskokhozyaystvennykh-kultur/kapelnoe-oroshenie-funduka/>).

Fruit plants are known to be pruned mainly in autumn and early spring. Since the hazel plant starts vegetation earlier compared to other fruit plants, it is considered more appropriate to prune it in autumn. Autumn pruning should be done after the leaves fall naturally (Karadeniz, 2008).

Bayramova and Sultanov (2017) studied productivity and fruit quality indicators of hazel varieties introduced at the Zagatala region base station of Azerbaijan Research Institute of Fruit-Growing and Tea-growing. Hazel varieties were introduced from Oregon State University in the USA and their adaptation characteristics to local soil and climate conditions were studied. It should be noted that the hazel orchard was planted in the Zagatala district in 2003 and consists of 15 introduced varieties. Among these varieties, Martarella (23.0 kg/tree), Tondo vi Fonni (21.0 kg/tree), Sanviovanni Clark (16.6 kg/tree), and Ennis (14.5 kg/tree) are the most productive. Kernel yield changes between 43.0-72.0% for common varieties. The highest kernel yield was observed in Martarella (72 %), Clark (72 %), and Levis (71 %) varieties.

Cherepenina, (2012) conducted research on the optimization of the construction of hazel plantations in the humid subtropical region of Russia. The researcher recommends planting hazel orchards in the form of single-stem stamped trees. Because, compared to shrubs, the fruit ripens 2-4 days earlier in hazel orchards of "Tatura" and "Agac", the yield increases to 69-84%, and the yield of kernels increases to 6%, depending on the varieties.

Based on the above, our research is related to the technology of hazel cultivation and is dedicated to a very relevant topic – the pruning of the hazel plant.

The research was conducted in the village of Ashaghi Tala, Zagatala region. Atababa and Yaghli findig varieties of the hazel plant were chosen as the study material.

Atababa. It is a tall shrub with a wide canopy. It has dense branching. The fruit is flat-rounded, medium-sized (2.5 g), and thick-skinned. It is a productive variety. The productivity per shrub is 15-20 kg, and for some shrubs, 25 kg. Kernel yield is 53%. The kernel is tasty and oily. The oil yield is 68.22%. It ripens in September.

Yaghli findig. It is a very tall (10 m) local variety. The fruits are oblong-round, bright-red, and the skin is thin and hard. The fruits are easily shed when ripe. The seat of the fruit is flat and tenderly hairy. Its weight is 3 g. Kernel yield is 48%, kernel oil is 73%, and nitrogenous substances are 16.47%. The kernel is wrapped with cork. Resistant to diseases and pests. It is a productive variety. One shrub yields up to 32 kg. It ripens in September.

The hazel orchard of the mentioned varieties was planted in 2000 and the trees are 22 years old. The food area was 8 x 8 m, and the number of plants per hectare was 156. As can be seen, the orchard was planted traditionally. Productivity per hectare is 1-1.2 tons. The number of stems per shrub ranged between 40 and 80.

## 2. Research methodology

The research was conducted based on generally accepted methods of horticulture (Moiseichenko, 1987; Sedova, 1999).

Thus, the volume and the projection area of the shrub were calculated by the formulae  $V=hxd^2/1.91$  and  $S=0.196(d_1+d_2)^2$ , respectively.

## 3. Results

The purpose of our research was the development of the technology for proper pruning of hazel shrubs. The main goal of pruning hazel trees was to increase productivity, improve product quality, and ensure the longevity of trees. Hazel shrubs were pruned according to the generally accepted rule, after the leaves were shed naturally

in autumn or until the buds emerge in early spring. Otherwise, the process of growth and development of plants is weakened.

Although hazel plants can live up to 200 years under natural conditions, the lifespan of hazel orchards in the republic does not exceed 40 years. The period of high productivity of hazel is approximately 7-25 years, depending on the soil and climate conditions. In the following years, the yield gradually decreases. Therefore, in the year of high productivity, the balance of the growth and development processes of hazel orchards is maintained by applying regulatory pruning.

At the same time, in productive hazel orchards, some stems are cut to decrease shrub density. Besides, wellness (sanitary) pruning is applied by cutting and discarding old, sick, and damaged stems. Upright and healthy trees should be kept to replace cut stems.

Hazel is a multi-stemmed plant with abundant root growth. During pruning, it is important to clean the growths that form between the hazel shrubs every year. Their presence causes the tree to weaken and the yield to decrease. The growths around the roots and stems should be cut and discarded twice during the vegetation period.

One of the main goals of pruning hazel orchards is to rejuvenate old plants. Rejuvenation can be done in two ways. The first method is to cut old and less productive stems completely from the base and keep only young stems. The disadvantage of this method is the impossibility to get a harvest from these orchards for 4-5 years. Therefore, such rejuvenation is carried out in parts in farms with large hazel fields, so that it does not result in a marked reduction of the overall productivity.

The second method of rejuvenation is to gradually prune old stems within a shrub and replace them with young ones. This type of rejuvenation is the most convenient method. The degree of pruning varies depending on the age of the tree and the biological characteristics of the variety.

Proceeding from the mentioned, we studied the biometric and productivity indicators of hazel shrubs before pruning and after pruning comparatively. Biometric indicators of hazel shrubs before pruning are presented in Table 1.

**Table 1.** Biometric indicators of hazel shrubs (before pruning)

Variety	Shrub height, m	The number of stems per shrub	Shrub diameter		Shrub volume, m <sup>3</sup>	Shrub projection area, m <sup>2</sup>
			d <sub>1</sub>	d <sub>2</sub>		
Ata-baba	6.8	56	5.0	4.8	85.48	18.83
Yaghli findig	7.5	64	5.2	4.5	92.37	18.44

As seen in Table 1, the height of the trees is 6.8 m in the Ata-baba variety and 7.5 m in the Yaghli findig variety, and the average number of stems per shrub varies between 56-64.

The diameter of the shrub was 5.0 m between the rows and 4.8 m between the plants in the Ata-baba variety. In the Yaghli findig variety, the shrub diameter was 5.2 m between rows and 4.5 m between plants. Based on the above, the volume of the shrub is 85.48 m<sup>3</sup> in the Ata-baba variety, and 92.37 m<sup>3</sup> in the Yaghli findig variety. The projection area of the shrub is one of the main factors for the optimal placement of plants in the orchard. The projection area of the shrubs before pruning was 18.83 m<sup>2</sup> in the Ata-baba variety, and 18.44 m<sup>2</sup> in the Yaghli findig variety.

The biometric indicators of the mentioned hazel varieties after pruning are shown in Table 2.

**Table 2.** Biometric indicators of hazel shrubs (after pruning)

Variety	Shrub height, m	The number of stems per shrub	Shrub diameter		Shrub volume, m <sup>3</sup>	Shrub projection area, m <sup>2</sup>
			d <sub>1</sub>	d <sub>2</sub>		
Ata-baba	3.2	12	3.5	3.8	22.32	10.44
Yağlı findiq	3.5	14	3.9	4.2	30.06	12.86

As seen in Table 2, after pruning, the biometric indicators of hazel shrubs decreased significantly. Thus, the height of the shrubs was 3.2 m in the Ata-baba variety, and 3.5 m in the Yaghli findig variety. This is 3.6-4.0 m less than the height of the shrubs before pruning. The number of stems in one shrub was reduced to 12 in the Ata-baba variety and 14 in the Yaghli findig variety. After pruning, the diameter of the shrubs also decreased and was 3.65 m in the Ata-baba variety and 4.05 m in the Yaghli findig variety on average. Accordingly, the volumes and the projection areas of the shrubs were also reduced significantly. Thus, the volume of the shrub was 22.32 m<sup>3</sup> in the Ata-baba variety, and 30.06 m<sup>3</sup> in the Yaghli findig variety. The projection area of the shrub was 10.44 m<sup>2</sup> in the Ata-baba variety and 12.86 m<sup>2</sup> in the Yaghli findig variety.

The yield coefficient of the varieties before and after pruning was also determined based on the average yield per shrub. The results are given in Table 3.

**Table 3.** Productivity indicators of hazel shrubs

Variety	Yield per shrub, kg		The coefficient of productivity of shrubs by varieties			
	Before pruning	After pruning	Before pruning		After pruning	
			kg/m <sup>3</sup>	kg/m <sup>2</sup>	kg/m <sup>3</sup>	kg/m <sup>2</sup>
Ata-baba	8	20	0.09	0.42	0.90	1.92
Yaghli findig	9	22	0.10	0.49	0.73	1.71

As seen in the table, the average yield per shrub before pruning was 8 kg in the Ata-baba variety and 9 kg in the Yaghli findig variety. After pruning, this indicator increased by 12-13 kg on average for the varieties and was 20 kg per shrub in the Ata-baba variety, and 22 kg per shrub in the Yaghli findig variety.

#### 4. Conclusion

Before pruning, the productivity coefficient of the shrubs, that is, the productivity index per m<sup>3</sup> volume of the shrub and per m<sup>2</sup> of the projection area was much lower. Because the volumes of the shrubs were too large, and the yield per shrub was low. So, before pruning, the productivity coefficient per shrub volume was 0.09 kg/m<sup>3</sup> in the Ata-baba variety, while after pruning, this indicator increased by 0.81 kg and amounted to 0.90 kg/m<sup>3</sup>. The same situation was observed for the projection area of the shrub. In the same variety, while this indicator was 0.42 kg/m<sup>2</sup> before pruning, it increased by 1.50 kg and amounted to 1.92 kg/m<sup>2</sup> after pruning.

The productivity coefficient of the Yaghli findig variety was 0.10 kg/m<sup>2</sup> before pruning, and after pruning it increased by 0.63 kg and amounted to 0.73 kg/m<sup>2</sup>. The

productivity coefficient of the shrubs on the projection area was 0.49 kg/m<sup>2</sup> before pruning and increased by 1.22 kg reaching 1.71 kg/m<sup>2</sup> after pruning.

Thus, as the famous Roman philosopher and agronomist Columella said: "Who takes care of the trees to get a harvest asks them, who gives fertilizer helps them, and who prunes forces them." Timely and proper application of regulatory and wellness (sanitary) pruning, especially in productive orchards can ensure a long productive period and high yield.

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