

The behavior of hazelnut cultivars in the eco-pedoclimatic conditions of the Bucharest area

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ABSTRACT

Hazelnut is an essential species for nut production worldwide; extensive orchard areas have recently been planted in Romania. To choose the best cultivars to be grown in the future, a study was done on the behavior of seven hazelnut cultivars in the eco-pedoclimatic conditions of the Bucharest area. 'Hall's Giant', 'Tonda Gentile delle Langhe', 'Romavel', 'Red Lambert', 'Tonda di Giffoni', 'Tonda Gentile Romana', and 'Vâlcea 22' were planted in the Experimental Orchard of the Faculty of Horticulture within the University of Agronomic Sciences and Veterinary Medicine of Bucharest. The results presented the behavior of hazelnut cultivars detailing the number of branches per tree, according to their age, and annually for each branch, length, and total cross-section area were measured. The influence of cultivars on yield and fruit characteristics at the harvest moment was detailed. 'Romavel' and 'Vâlcea 22' had the fruits with the highest weight, more than 3.3 g/fruit, while 'Red Lambert' and 'Tonda di Giffoni' presented the lowest values. 'Hall's Giant' was the most vigorous cultivar, and 'Vâlcea 22' the less vigorous. Interesting growth dynamics for each cultivar and all studied branches in the two experimental years were detailed. First and second-year branches had the highest TCSA growth rhythm, but that was not maintained for the third to fifth-year branches.

Keywords: *Corylus avellana*, fruit, tree vigor, annual growth

INTRODUCTION

Hazelnut (*Corylus avellana*) is an essential species for nut production worldwide; extensive orchard areas have recently been planted in Romania. Hazelnuts, walnuts, and almonds are known for their large amounts of protein and fat. The content of protein substances (12-28%), carbohydrates (12-22%), and mineral salts (2-3.05%) places hazelnuts ahead of walnuts, and the fat content (52-69%) is higher than that of almonds. Compared to other nuts, Hazelnuts also contain salts of potassium, phosphorus, magnesium, and calcium, which play an essential role in human metabolism. The fruits are consumed fresh but mainly processed and widely used in the food industry. The oil extracted from hazelnuts is also used in the pharmaceutical industry, cosmetics, industrial varnish manufacture, and painting (Cimpoieș, 2018). Worldwide, the production of hazelnuts in the shell was, at the level of 2021, 1,077,117.1 (150% increase compared to

1994 production) tones from 1,039,147 ha (doubled than 1994 surface). Asia (77.2%) and Europe (17.7%) have the highest production. Turkiye, followed by Italy, is the biggest producer in the world (Faostat, 2023). In Romania, correlated to the investments received in the fruit-growing domain, there was an increase in the hazelnut orchards, with a large number with organic technology. Hazelnut is a shrub species resistant to frost, cold, diseases, and pests; it is easy to grow with low maintenance costs; it provides high yields and incomes in small areas and is easily harvested by hand and shaking at full maturity (Botu, 1987). The assortment of hazelnut cultivars is relatively small worldwide compared to other fruit species and consists of cultivars adapted to certain areas. There is ongoing research into breeding and genetics to improve hazelnut production and quality. This includes the development of new cultivars with desirable traits such as disease resistance, yield, and nut size.

The behavior of hazelnut cultivars can vary depending on the eco-pedoclimatic conditions of the area where they are grown. Some factors that can affect the growth and productivity of hazelnut cultivars include temperature, rainfall, soil type, and exposure to wind and other environmental stresses.

Temperature: Hazelnut cultivars have different temperature requirements for optimal growth and nut production. For example, some cultivars are adapted to cooler climates and may not perform well in regions with hot summers. In general, hazelnuts prefer moderate temperatures, with an average annual temperature range of 8-15°C optimal.

Rainfall: Hazelnuts require adequate moisture to grow and produce nuts, but excessive rainfall or poorly drained soils can lead to root rot and other fungal diseases. Drought stress can also impact hazelnut growth and yield, especially in regions with low rainfall or limited water resources.

Soil type: Hazelnuts prefer well-drained soils with good fertility and a pH between 5.5 and 7.5. They can grow in various soil types but best in sandy loam or loamy soils. Soil structure and nutrient availability can impact hazelnut growth and productivity.

Environmental stresses: Hazelnut cultivars may be exposed to a cultivar of environmental stresses, including wind, frost, and pests and diseases. Wind can cause physical damage to the trees and reduce nut yield, while frost can damage buds and flowers and reduce nut set. Pests and diseases can also impact hazelnut productivity.

Overall, the behavior of hazelnut cultivars in eco-pedoclimatic conditions is complex and can vary depending on various factors. Cultivar selection, management practices, and environmental monitoring can all play a role in optimizing hazelnut growth and productivity in different regions. Extended research was performed in specific hazelnut growing areas to optimize the specific cultivars' usage or technology. Shahi-Gharahlar *et al.* (2016) evaluated the performance of six hazelnut cultivars under drought. Ozenc (2014) researched the potassium fertilizer requirements in hazelnuts. Iordănescu *et al.* (2014) characterized some of the hazelnut cultivars in the southern area of Timis County. Cosmulescu *et al.* (2013) presented the mineral composition profile in different hazelnut cultivars.

This study aims to present the results of two-year research regarding the behavior of seven cultivars in the Bucharest area.

MATERIALS AND METHODS

In order to choose the best cultivars to be planted in the future, a study was done regarding the behavior of seven hazelnut cultivars in the eco-pedoclimatic conditions of the Bucharest area. 'Hall's Giant', 'Tonda Gentile delle Langhe', 'Romavel', 'Red Lambert', 'Tonda di Giffoni', 'Tonda Gentile Romana', and 'Vâlcea 22' were planted in the Experimental Orchard of the Faculty of Horticulture within the University of Agronomic Sciences and Veterinary Medicine of Bucharest (44°25'57"N, 26°6'14"E, 90 m altitude).

The 'Hall's Giant' is a cultivar of unknown origin, with great vigor, erect habit, and few suckers. Easy to be led with a single stem. Flowering is in February; the cultivar is precocious and bears well and consistently (Turcu *et al.*, 2001). The fruit is large (3.6 g), ovoid, elongated. The yield in the core is 48-49%. The fruits ripen in the third decade of September.

The 'Tonda Gentile delle Langhe' cultivar is of Italian origin, and medium vigor. It blooms early (January-February). The cultivar is precocious, very productive, and bears fruit year after year. The fruit is medium to small (2.3 g) and round in shape. The core has a yield of 49%. Fruit ripening is early, starting from the second decade of August. It is sensitive to *Botrytis* and *Eriophyidae*. It is considered the most valuable cultivar for the chocolate industry. It can be grown in areas with less frosty winters.

The 'Romavel' cultivar is of Romanian origin, with plants of great vigor. It blooms late (end of February-beginning of March) and is homogamous. It begins fruiting quickly and bears fruit very well and constantly. The fruit is medium to small (2.8 g), round-compressed. The yield in the core is 49.51%. Fruit ripening is early, in the second decade of August. The cultivar is resistant to frost, bacteriosis, and hazelnut spiders. It is recommended for all favorable cultivation areas under irrigation conditions.

The 'Red Lambert' cultivar has medium vigor; the leaves and involucre are colored garnet-red, and small, ovoid fruits, 5-10 in the involucre, with 53-59% core, of excellent quality. It ripens at the end of August.

The 'Tonda di Giffoni' is a medium-early cultivar, fruit harvesting begins in the third decade of August. Is precocious and productive. The fruits have woody skin, the center is round brown with a distinct band and very pronounced grooves on the sides. It goes into production as early as year 3-4, with a productivity of 4-5 tons per hectare.

The 'Tonda Gentile Romana' is medium vigor, with very strong stemming, has frost-sensitive seeds, and is precocious and reasonably productive. This cultivar is similar to 'Mari de Piedmont,' from which it differs by the shorter involucre, the costlier fruits, and the more convex base; the ripening of the fruits is later.

The 'Vâlcea 22' is a Romanian cultivar with low-vigor plants and many suckers. It flowers early (January-February) and is protogynous – homogamous. The fruit is large (3.5–4.0 g), round-compressed, and light brown. The core has a yield of 48%. Ripening occurs in the first decade of September. It is early and productive; the fruits are intended for direct consumption and are resistant to frost and diseases.

At the study, the plants were six years old. Distance planting was at 4.5 x 2.0 m. An integrated technology was applied with no pesticides or chemical fertilizers. Irrigation of the analyzed cultivars was applied in the dry years with norms of 350-400 m³/ha. Four plants/cultivars were studied, determining the number of branches per tree according to their age. Annually, the length and total cross-section area were measured for each branch. For the descriptive statistics of the data, Microsoft Excel 2016 and IBM SPSS v. 28.0.1.1 were used for a significance level of $p = 0.05$.



Figure 1. Romanian hazelnut cultivars 'Romavel' and 'Vâlcea 22' (source Cociu, 2011)

RESULTS AND DISCUSSIONS

The research results on the behavior of hazelnut cultivars in the eco-pedoclimatic conditions of the Bucharest area expressed the influence of cultivars on the number and length of shoots by age on the shoot's cross-sectional area and growth rate. At the same time, fruit characteristics at the harvest moment were detailed.

In the first year, 'Tonda Gentile delle Langhe', 'Romavel', and 'Vâlcea 22' presented the highest number of new shoots. In the second year, all the cultivars presented fewer new shoots due to the technologies applied with severe pruning. In the bush architecture, the 4th and 3rd-year shoots were more numerous (Fig 2 and 3), the value ranged between 18% ('Tonda Gentile Romana') and 28% ('Romavel') at 3rd-year shoots and between 16% ('Vâlcea 22') and 31% ('Tonda Gentile Romana') for 4th-year shoots.

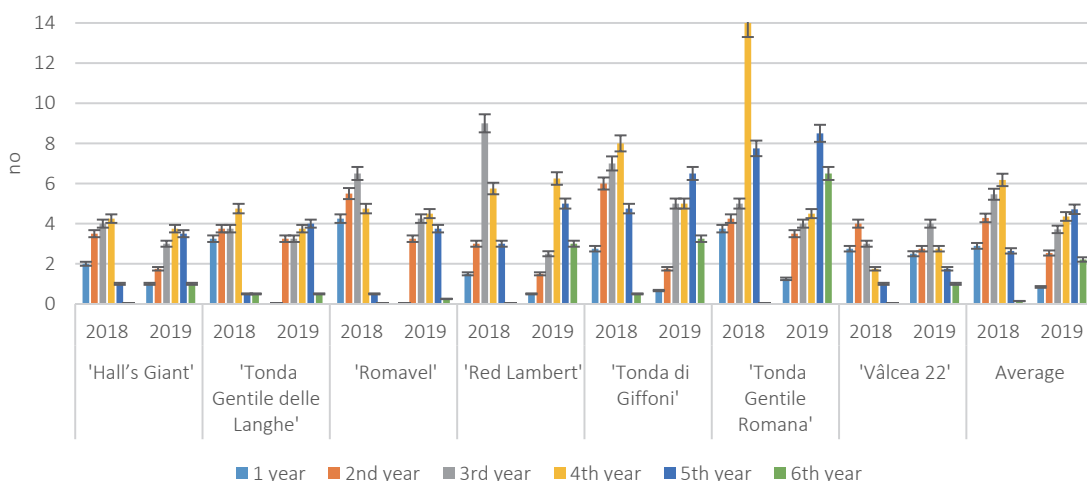


Figure 2. The influence of the cultivar on the number of shoots by age

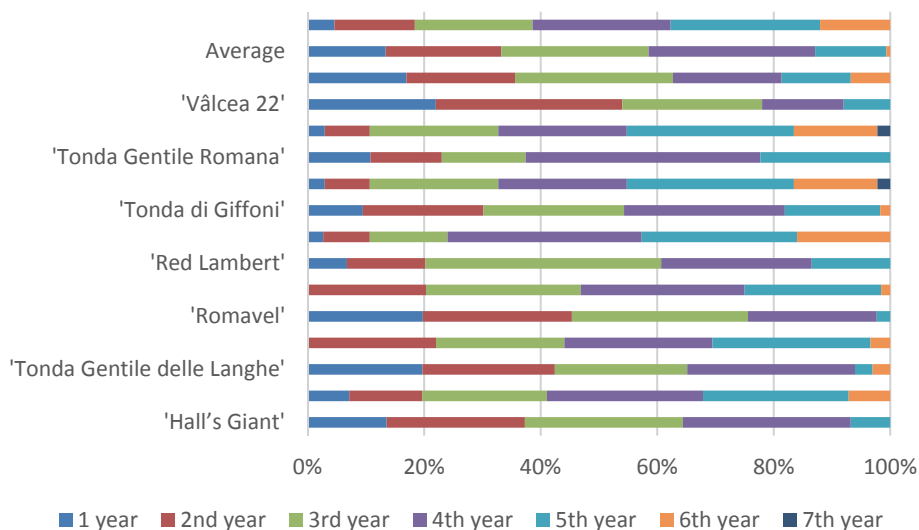


Figure 3. The rate of shoot number

For each variant, shoot length was measured in each year of the study and varied from one cultivar to another. In the shoots of the first year, the average length varied between 1.03 m ('Vâlcea 22') and 2.01m ('Romavel'), the shoots of the 2nd-year shoots had values between 1.21 m ('Vâlcea 22') and 2.43 m ('Romavel'), 3rd-year shoots between 1.24 m

('Válcea 22') and 3.14 m ('Hall's Giant'), 4th year shoots between 2.07 m ('Válcea 22') and 3.43 m ('Romavel') expressing the dynamic of growth specific for each year of the shoots. The results showed that the lowest vigor was highlighted in the 'Válcea 22' cultivar and high vigor for 'Romavel', the other cultivars analyzed registered intermediate values. The rate in total growth length is presented in Figure 4.

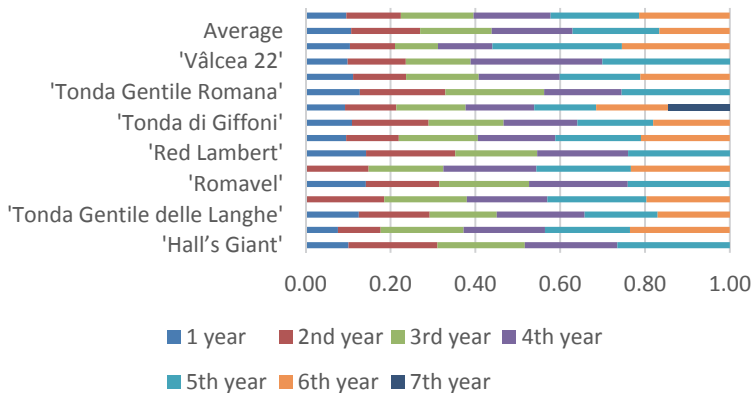


Figure 4. The rate of shoot length

Each year, the shoot's cross-sectional area (cm²) was measured for every shoot type. The results presented the growth dynamic for shoot age (Table 1). The influence of the cultivar on the shoot's growth is presented in Figure 5. The highest growth for all cultivars is in the second year compared to the first year, followed by the third and fourth years. The growth rhythm is slowed after the shoot cross-sectional area.

Table 1. The influence of the cultivar on the shoots cross-sectional area (cm²)

Year	'Hall's Giant'		'Tonda Gentile delle Langhe'		'Romavel'		'Red Lambert'		'Tonda di Giffoni'		'Tonda Gentile Romana'		'Válcea 22'		Average	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
1st	0.80	1.06	1.02		0.86		1.16		0.78	1.10	0.95	1.38	0.78	0.61	0.91	1.04
2nd	4.16	2.31	3.88	3.10	2.36	1.98	4.51	2.41	3.20	2.11	2.49	2.08	1.58	1.76	3.17	2.25
3rd	8.00	8.21	5.32	6.60	6.16	4.00	4.69	6.22	5.06	5.78	5.29	4.91	2.29	2.48	5.26	5.46
4th	15.29	10.44	9.92	8.72	16.36	11.91	8.85	8.30	7.04	8.79	3.52	8.02	7.92	3.43	9.85	8.52
5th	26.30	19.27	19.20	13.68	10.74	20.48	15.00	11.29	8.27	10.21	10.90	5.69	10.97	17.12	14.48	13.96
6th		30.83	8.94	20.02		39.32		18.20	14.17	15.80		16.23		15.29	11.55	22.24

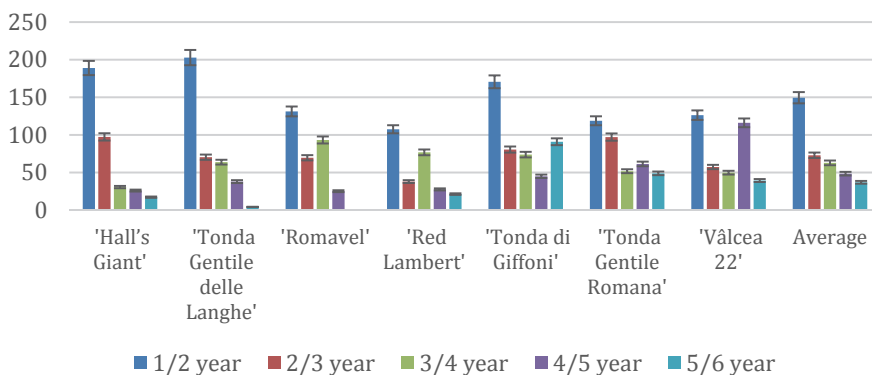


Figure 5. The influence of the cultivar on the shoots cross-section area growth rate (cm²)

For each cultivar, fruit weight and percentage of the seeds (Table 2) were evaluated. 'Hall's Giant' and 'Tonda Gentile delle Langhe' while 'Romavel' had fruits with higher values (3.44 g compared to 2.8 g). 'Vâlcea 22' had also results compared to the literature (3.3 g compared to 3.5-4.0 g). More research is needed to have a conclusive report on productivity.

Table 2. The influence of the cultivar on the shoot's cross-sectional area

Cultivar	Fruit (g)	Seed (g)	Seed ratio (%)
'Hall's Giant'	1.699	0.853	50%
'Tonda Gentile delle Langhe'	1.667	0.480	29%
'Romavel'	3.442	1.405	41%
'Red Lambert'	1.158	0.420	36%
'Tonda di Giffoni'	0.808	0.168	21%
'Tonda Gentile Romana'	1.685	0.609	36%
'Vâlcea 22'	3.301	1402	42%

CONCLUSIONS

The present study showed details regarding seven cultivars' behavior in South Romania using integrated technology. 'Romavel' and 'Vâlcea 22' had the fruits with the highest weight, more than 3.3 g/fruit, while 'Red Lambert' and 'Tonda di Giffoni' presented the lowest values. 'Hall's Giant' and 'Romavel' were some of the most vigorous cultivars, and 'Vâlcea 22' was the least vigorous.

Interesting growth dynamics for each cultivar and all studied branches in the two experimental years were detailed and influenced by the cultivar and the annual climatic conditions. First and second-year branches had the highest CSS growth rhythm, but that was not maintained for the third to fifth-year branches.

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