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FLORAL BIOLOGY AND POLLEN QUALITY OF SOME HAZELNUT CULTIVARS FROM THE NORTHERN PART OF OLT COUNTY

Duță Petre[1], Botu Mihai[2]
[1]Doctoral School of Engineering of Animal and Plant Resources (IRAV), University of Craiova, Romania
[2]Faculty of Horticulture, Dept. of Horticulture and Food Science, University of Craiova, Romania
Corresponding author. E-mail: petreduta@gmail.com

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ABSTRACT

The aim of this study was to study the floral biology and pollen quality of 4 hazelnut cultivars ('Romavel', 'Vâlcea 22', 'Uriaș de Halle' and 'Tonda Gentile delle Langhe' ('TGDL') cultivated in Leleasca area, Olt County, Romania. We carried out the observations regarding the phenology of hazelnut (using BBCH scale), the degree of dichogamy, and the viability (in carmine acetic) and germination capacity of the pollen (on solid medium with sucrose and agars). The flowering period spanned two months (from January to February). Regarding the phenomenon of dichogamy, 2 cultivars were protandrous, one was protogynous and one was homogamous. The average pollen viability value was 61.43 %, ranging from 54.71 % for the 'Vâlcea 22' cv. to 70.27 % for the 'Romavel' cv. The mean value of pollen germination capacity was 22.87 % ranging from 19.35 % for the 'TGDL' cv. to 28.22 % for the 'Romavel' cv. These results provide information on the potential for using a cultivar as a genitors in controlled hybridization, as well as a pollinator in commercial orchards.

INTRODUCTION

Worldwide, the hazelnut (*Corylus avellana* L.) is one of the important fruit-bearing species (Novara et al., 2016; Brandoli et al., 2024).

The area cultivated with hazelnut în 2024 was 1,108,901 hectares and production obtained was 1,212,125 tones (FAO Stat Database, 2026). Among the continents, Asia is the largest producer of hazelnuts with 878,240 hectares and 885,421 tones, which represent about 73% of world production. The largest hazelnut-growing countries are Turkey with 749,769 hectares and 717,000 tonnes, followed by Italy with 90,390 hectares and 120,520 tonnes, the Americas with 35,613 hectares and 87,82 tonnes, and China with 11,777 hectares and 25,436 tonnes (FAO Stat Database, 2026).

In Romania, interest in hazelnut cultivation has grown significantly in recent years, manifesting in the establishment of several hundred hectares of modern orchards; as of 2024, a total of 1,900 hectares of hazelnut plantations were recorded, yielding a production of 3,950 tonnes (FAO Stat Database, 2026).

The current trend points to a sustained increase in plantings of this fruit-bearing species.

In the last period, funding provided through sub-measures launched by the Ministry of Agriculture and Rural Development has allocated significant sums to the

fruit-growing sector; this, combined with the efforts of other investors using their own capital, has led to an explosion of surfaces and the number of hazelnut orchards across most regions of the country (5,374.93 hectares, respectivelly 110 farms): Maramureș and Moldova – 19 farms with 213.95 hectares; Transilvania – 32 farms with 775.25 hectares; Banat and Crișana – 29 farms with 3,669.20 hectares; Dobrogea – 11 farms with 417.38 hectares; Munenia and Oltenia – 19 farms with 299,15 hectares.

The hazelnut is a monoecious species, with male and female flowers situated separately but on the same plant (Germain, 1994; Turcu et al., 2001; Guo et al., 2009; Falistocco and Marconi, 2013).

The flowering period of the hazelnut is a characteristic of the species. The flowering of the female blossoms is indicated by the emergence of styles from the flower buds, featuring red stigmas. The earliest flowering of female blossoms has been observed in the 'Tonda Romana', 'Tonda Gentile delle Langhe', and 'Cozia' cultivars; in some years, the female flowers of these varieties bloom during the first half of January (Cociu et al., 2003). In other cultivars - such as 'Romavel', 'Uriaș de Halle', and 'Lambert Red'-the female flowers bloom late, after the middle of February.

The flowering phenophase of the male blossoms may coincide with, or differ from, that of the female blossoms.

The specific climatic conditions in the geographical areas influence the annual cycle of hazelnut varieties, floral induction, flowering period, and the timing of pollination, fecundation, and fruit set (Trotter, 1951; Turcu et al., 2001; Taghavi et al., 2020).

The onset of flowering is directly related to the sum of positive temperatures, calculated from the date when the first 3–6 days with sub-zero daily temperatures were recorded during November or December. From this point on, the hazelnut is considered to have emerged from its phase of absolute dormancy.

The mean sum of temperatures above 0 °C recorded during the winter period influences the flowering of male and female blossoms differently, depending on the cultivar. Specifically, male blossoms bloom once a cumulative positive temperature sum is reached - ranging from 98.5 °C (e.g., 'Tonda Romana') to 147.2 °C (e.g., 'Lungi de Spania') (Cociu et al., 2003). For female blossoms, a cumulative positive temperature sum of 125.1 °C is required - a value very similar to that for male blossoms - with figures varying by variety from 101.9 °C (e.g., 'TGDL') to 147.2 °C (e.g., 'Romavel').

Understanding the timing of flowering and the prevailing climatic conditions allows for informed decision-making - both in selecting the appropriate range of varieties for a specific region and in choosing parent plants for breeding programs (Turcu et al., 2001; Cociu et al., 2003).

Dichogamy - the lack of synchronization between the flowering times of female and male flowers - also occurs in hazelnuts. This phenomenon is of particular importance for ensuring pollination, as hazelnut cultivars are generally self-sterile or self-incompatible. In hazelnut cultivars, dichogamy manifests in three forms: protandry (male flowers bloom first), protogyny (female flowers bloom first), and homogamy (both types of flowers bloom simultaneously).

In hazelnut cultivars, male flowers are grouped into catkins, while female flowers are arranged in inflorescences known as glomerules; the number of these varies by cultivar. The average number of male inflorescences ranges from 1,480 in the 'Tonda Romana' cv. to 2,880 in the 'Daviana' cv. For hazelnut cultivars, both the

number of female inflorescences - which determine nut yield - and the number of catkins - which provide the pollen necessary for wind-driven (anemophilous) pollination - are significant. In plants at full production, the number of glomerules varies between 465 in 'Tonda Romana' and 906 in 'Gunslebert'.

Each catkin contains 150–200 flowers and produces 5–8 million pollen grains by the end of winter (Trotter, 1930; Soltesz and Nyeki, 2000; Piotrowska, 2008).

Female flowers are generally receptive to pollen for several weeks or longer (Molnar, 2011); if pollination does not occur, the stigma may remain receptive for up to 3 months (Olsen, 2013; Balik et al., 2023). The hazelnut pollen grain is very small and light; therefore, pollination is anemophilous (via wind) (Olsen, 2013; Taghavi et al., 2022).

Considering the above, the aim of this study was to study the floral biology and pollen quality of 4 hazelnut cultivars ('Romavel', 'Vâlcea 22', 'Uriaș de Halle' and 'Tonda Gentile delle Langhe' ('TGDL') cultivated in Leleasca area, Olt County, Romania.

MATERIAL AND METHODS

The research was carried out in a hazelnut orchard covering an area of 9.15 hectares, located in Leleasca area, Olt County, on soil classified as a Luvisol. The trees were planted at a spacing of 5 × 3 m and cultivated under irrigation; each tree was equipped with three drippers (one 4 l/h dripper positioned at the tree itself and one 8 l/h dripper on either side - providing a total irrigation rate of 20 l/h per hazelnut tree).

In Leleasca area, the average annual temperature is 10.8 °C, with fluctuations between 10.1 °C and 11.2 °C - based on a 50-year average. Absolute minimum temperatures have ranged from -20 °C to -9 °C. The average of the recorded minimums was -13.9 °C.

The following cultivars were evaluated: 'Romavel' (syn. 'Romnut'), 'Uriașe de Halle', 'Vâlcea 22', and 'Tonda Gentile delle Langhe'.

The following observations and determinations were carried out:

1. Phenological observations from the beginning to the end of the flowering phase, using the BBCH scale (Paradinas et al., 2022; Taghavi et al., 2022; Toillon et al., 2023). The following phenological stages were considered: for the development stages of male flowers, stage R01 – emergence of catkins; for the development stages of female flowers, stage R07 – onset of flowering in female flowers.

2. Determination of pollen viability and germination capacity

Pollen viability was determined using the aceto-carmine staining method; fertile pollen grains stain carmine red, while sterile pollen grains stain pale pink or remain colorless.

Regarding pollen viability, the studied cultivars were classified into viability classes according to UPOV descriptors (Table 1).

Pollen germination capacity was determined *in vitro* by culturing on a solid medium (15% sucrose, 1.5 g agar, 0.01 g boric acid in 100 ml distilled water) under laboratory conditions (temperature 18–20°C and relative humidity 70–90%).

Germination was assessed in the laboratory one week after pollen collection and its use in hybrid combinations; results were recorded 6 hours after sowing the pollen onto the aseptic medium in Petri dishes.

Regarding pollen germination capacity, the studied cultivars were classified into viability classes according to UPOV descriptors (Table 2).

Observations regarding pollen viability and germination were conducted using an OPTIKA 383 PL microscope (Italy) equipped with Proview software and a 10x ocular lens.

Table 1

UPOV descriptors (TG 71/3; 2022) – pollen viability

Characteristic	Class	Value	Note
Pollen viability (%)	Very high	>79	9
	High	65-78	7
	Medium	51-64	5
	Low	37-50	3
	Very low	<36	1

Table 2

UPOV descriptors (TG 71/3; 2022) – pollen germination capacity

Characteristic	Class	Value	Note
Pollen germination capacity (%)	Very high	>66	9
	High	53-65	7
	Medium	41-52	5
	Low	28-40	3
	Very low	<27	1

3. Statistical analysis. The data were included in an Excel database and statistically interpreted with the SPSS 14.0 program, which uses the Duncan test (multiple t tests) at 0.05 level of probability.

RESULTS AND DISCUSSIONS

1. Phenological observations

In the Leleasca area, the flowering period spanned two months (from January to February) (Table 3).

Regarding the blooming of male flowers, the 'TGDL' cv. was the earliest (beginning of January), while the 'Uriaș de Halle' cv. was the latest (Table 3).

Regarding the flowering of female flowers, the earliest variety was 'Uriaș de Halle' (January, 11), while the latest was 'Vâlcea 22' (January, 19) (Table 3).

Regarding the phenomenon of dichogamy, male flowers generally bloom before female ones, exhibiting a tendency toward protandry. In the 'TGDL' and 'Uriaș de Halle' cvs., the male flowers bloomed first, demonstrating a tendency toward protandry. 'Vâlcea 22' cv. was protogynous, with female flowers blooming a few days before the male flowers, while in the 'Romavel' cv., the blooming of both types of flowers occurred at approximately the same time (Table 3).

Turcu et al. (2001) reported the 'Romavel' and 'Tonda Gentile delle Langhe' cultivars as homogamous. In our study, 'Romavel' is homogamous, while 'Tonda Gentile delle Langhe' is protandrous. Soltesz and Nyeki (2000) describe the 'Tonda Gentile delle Langhe' cultivar as protandrous.

Table 3

The flowering period of flowers on the studied hazelnut cultivars

No.	Cultivar	Flowering of male flowers		Flowering of female flowering		Nature of dichogamy
		Beggining	Ending	Beggining	Ending	
1	(TGDL)	04.01.2026	23.02.2026	08.01.2026	10.03.2026	Protandrous
2	Uriaș de Halle	02.02.2026	27.03.2026	05.02.2026	27.03.2026	Protandrous
3	Vâlcea 22	11.01.2026	25.02.2026	09.01.2026	08.03.2026	Protogynous
4	Romavel	01.02.2026	16.03.2026	28.01.2026	26.03.2026	Homogamous

'TGDL' exhibited the longest flowering period (61 days for female flowers and 51 days for male flowers). The shortest flowering period was recorded for the 'Vâlcea 22' and 'Romavel' cultivars in the case of male flowers (46 days and 44 days, respectively), and for the 'Uriaș de Halle' cultivar in the case of female flowers (50 days) (Table 4).

Table 4

Period of flowering and quality of catkins

No.	Cultivar	Duration of flowering (day)		Quantity of catkins	Distribution of catkins
		♂	♀		
1	TGDL	51	61	Abundant	Uniform
2	Uriaș de Halle	54	50	Abundant	Uniform
3	Vâlcea 22	46	55	Medium	Uniform
4	Romavel	44	57	Medium - high	Uniform

Regarding the quantity of catkins, most of the studied genotypes possess a large number of catkins distributed uniformly (Table 4). Our results are consistent with those reported by Brandoli et al. (2023) for the 'TGDL' cultivar and, also by Stan et al. (2024) for the 'TGDL' and 'Romavel' cultivars.



Figure 1. Blooming of male and female flowers

2. Pollen viability

The mean pollen viability was 61.43 %, ranging from 54.71 % for the 'Vâlcea 22' cultivar to 70.27 % for the 'Romavel' cultivar. Overall, all the cultivars studied exhibited a high percentage of viable pollen (over 50 %). Our results are consistent with those obtained by Brandioli et al. (2023) for 'Tonda Gentile delle Langhe' (Table 5).

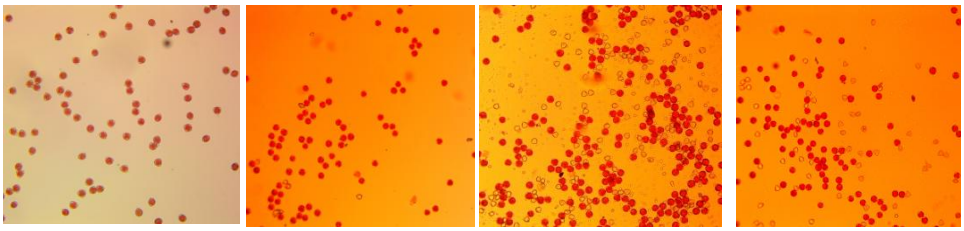


Figure 2. Pollen viability of 'TGDL', 'Uriaș de Halle', 'Vâlcea 22' and 'Romavel' cvs.

Regarding 'Tonda Gentile delle Langhe', some authors have reported a high proportion of sterile pollen (Olsen et al., 2000; Novara et al., 2017); however, in our study, this cultivar showed approximately 60 % pollen viability.

The results are also similar to those reported by Stan et al. in 2024.

In terms of pollen viability, the studied cultivars were grouped into 2 classes, according to UPOV descriptors: class 5–medium viability (51–64 %): 'TGDL', 'Uriaș de Halle', and 'Vâlcea 22'; class 7-high viability (65–78 %) - 'Romavel' (Table 5).

Table 5

Pollen viability of hazelnut cultivars studied

No.	Cultivar	Pollen viability (%)*	Descriptors UPOV clasification
1	TGDL	60.24 b	5
2	Uriaș de Halle	60.52 b	5
3	Vâlcea 22	54.71 c	5
4	Romavel	70.27 a	7
	Average	**61.43**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

2. Pollen germination capacity

The mean value for pollen germination capacity was slightly lower than pollen viability, averaging 22.87 % and ranging from 19.35 % for the 'TGDL' cv. to 28.22 % for the 'Romavel' cv. (Table 6).

In terms of pollen germination capacity, the studied cultivars were grouped into two classes, in accordance with UPOV descriptors (Table 6): class 1–low germination (<25 %): 'TGDL', 'Uriaș de Halle', and 'Vâlcea 22'; class 3–high germination (28–41 %) - 'Romavel'.

Table 6

Pollen germination capacity of hazelnut cultivars studied

No.	Cultivar	Pollen germination capacity (%)	Descriptors UPOV clasification
1	TGDL	19.35 d	5
2	Uriaș de Halle	23.11 b	5
3	Vâlcea 22	20.80 c	5
4	Romavel	28.22 a	7
	Average	**22.87**	

*Duncan multiple ranges test. Numbers followed by the same letter within a column are not significantly different (P≤0.05).

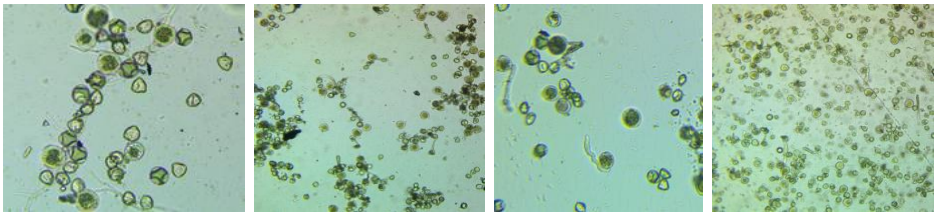


Figure 3. Pollen germination capacity of 'TGDL', 'Uriaș de Halle', 'Vâlcea 22' and 'Romavel' cvs.

These results are similar to those reported by Stan et al. (2024). Balik et al. (2023) reported pollen germination rates ranging from 15% to 78% for certain Turkish hazelnut genotypes. Beyhan and Odabaș (1997) reported a pollen germination capacity of 27–76% for some Turkish cultivars, while Fatahi et al. (2014) reported a germination of over 60% for certain hazelnut cultivars.

CONCLUSIONS

The results concerning the floral biology and pollen quality of hazelnut provide information on the suitability of a cultivar to serve as a parent in controlled hybridization, as well as a pollinator in commercial orchards. Pollinators must produce a large number of catkins, and their pollen must exhibit high viability and germination rates.

In our study, the 'Romavel' cultivar stood out due to its late flowering and high pollen viability and germination.

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