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# RESULTS ON THE VARIABILITY AND CHARACTERIZATION OF THE FLOWERING PERIOD AT THE WALNUT GENOTYPES FROM THE RIFG PITESTI COLLECTION

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### Abstract

At the walnut, the flowering period is variable depending on the variety. The flowering of female and male flowers on the same tree is offered over time, which favors dichogamy. This paper presents the results regarding the flowering period of 45 walnut accessions from the RIFG Pitesti collection. The results showed that, out of a total of 45 genotypes studied, 29 are protandrous (64.4%), 12 are protogynous (26.6%) and 4 are homogamous (9%). Regarding the flowering time, in the climatic conditions from RIFG Piteşti, in the spring of 2023, at the walnut varieties studied, on average the beginning of flowering of the male flowers took place between the third decade of April and the first decade of May, in time what the beginning of the flowering of female flowers took place in about the same period, but a few days later. Thus, were noticed by early to middle flowering, varieties such as 'Şuşiţa', 'Peştişani', 'Novaci', 'Recea', 'Secular', 'Schinoasa', 'Victoria', 'Vlădeşti', and by medium to late flowering, varieties such as 'Argeşan', 'Ciprian Ion', 'Geoagiu 265', 'Jupâneşti', 'Mihaela', 'Roxana', 'Sarmis', 'Sibişel 44', 'Velniţa', 'Orastie'. Also the foreign varieties ('Hartley' and 'Tehama') have noticed by late flowering.

Keywords: blooming, dichogamy, genotypes, germplasm, walnut.

## **1. INTRODUCTION**

Worldwide, walnut is an important nut tree species producing wood, kernel and edible oil. The nuts have high health care value, and the trees have a high adaptability, becoming a source of income for farmers all over the world (Zhang et al., 2014).

In Romania, the walnut surface is 2,830 hectares which ensures a production of 53,400 tones, our country being in  $5^{th}$  place in the world and  $2^{nd}$  in the European Union (Date FAO, 2024).

Currently, with increasing of the walnut cultivation area in Romania as a result of Sub-measure 4.1.a. Investments in fruit growing holdings, problems have started to appear, such as: susceptibility to diseases and pests, vulnerability to early spring and late frost damage and last but not least inappropriate and unadapted cultivars as well as an incorrect association of them in the orchard from the point of view of flowering and dichogamy.

At the walnut, the flowering period is variable depending on the variety. The flowering of female and male flowers on the same tree is offered over time, which favors dichogamy (Cociu et. al, 2003, 2007).

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The cultivars in which the male flowers bloom first are called protandrous, those in which the female flowers bloom first are called protogynous, and those in which both types of flower bloom simultaneously are called homogamous.

The intensity of dichogamy depends on the genotype, but also on the climatic conditions. Thus, it was found that under conditions of climate change, i.e. large temperature fluctuations, the cultivars react differently. The warm springs speed up the development of the male flowers, and the female flowers are not affected, thus making it possible to switch the cultivars from protogynous to homogamous, especially in the cultivars where the flowering differences between the two types of flowers is small (Cosmulescu, 2000; Cosmulescu et al., 2001; Pintea, 2004; Khadivi-Khub et al., 2015; Bîrsanu and Cosmulescu, 2017).

Numerous researches on the type of walnut flowering have shown that in Eastern Europe most cultivars are protandrous, but there are also quite a few protogynous varieties. Thus, in Slovenia, 45% of cultivars are protandrous and 55% are protogynous (Solar et al., 1995; Solar and Stampar, 2006); in France, 80% of cultivars are protandrous, 15% protogynous and 5% homogamous (Germain et al., 1999); in Turkey, 56% are protandrous varieties, and 44% are protogynous (Akca et al., 1997, 2004); in Serbia, 80% are protandrous varieties, 12% protogynous and 8% homogamous (Korac et al., 1997; Cerovic et al., 2010).

And in our country, approximately 60% are protandrous cultivars, 33% are protogynous and 7% are homogamous (Cociu et al., 2003; Cosmulescu and Botu, 2002, 2010).

The aim of this paper is evaluation of flowering period at 45 walnut accessions, from collection located in RIFG Pitesti, Romania.

# 2. MATERIALS AND METHODS

Plant material, field trial and climatic conditions

Plant material was represented by 45 walnut accessions (32 Romanian genotypes; 10 Moldavian genotypes; 3 American cultivars; 3 trees per accession) from collection planted in 2019 in Propagation Laboratory from RIFG Pitesti, Romania.

The planting distance was 8 m between rows and 6 m between the trees; the crown shape was flat open center; the walnut collection is provided with drip irrigation system.

The collection is located on a soil with high content in clay and low content in humus.

In the year 2023 when the observations were performed, the average temperature was  $12.3^{\circ}$ C, the maximum temperature was  $36.0^{\circ}$ C, and the minimum temperature was  $-11.4^{\circ}$ C; the total annual precipitation was 562.8 mm.

In the Maracineni area, where the observations were made, there is a 54-year-old data base with climatic parameters. Thus, compared to these multiannual climatic data it was found that the average temperature was slightly higher, and the amount of precipitation was much lower.

The flowering time was appreciated by noting the calendar date of the moment when female and male flowers begin to bloom.

The degree of dichogamy was calculated according to the formula suggested by Solar et al. (1997).

Degree of dichogamy (%) = 1-No. of days when male and female blooming coincides/ No. of days of female blooming X 100

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# 3. RESULTS AND DISCUSSIONS

Regarding flowering type, inside of Romanian cultivars group, 17 genotypes were protandrous (respectively 53.13%), 12 genotypes were protogynous (37.50%) and only 3 genotype were homogamous 9.37%) (Table 1; Fig. 1).

The climatic conditions have a great influence on the intensity of dichogamy, in the sense that in warm springs the male flowers bloom faster, and the female ones are not influenced. Also, under the conditions of the warming weather, some cultivars go from protogynous to homogamous.

This probably explains why 'Jupânești' cv. is described by some authors as protandrous (Braniște et al., 2007; Corneanu et al., 2018), and by others as protogynous (Cociu et al., 2003; Marin, 2005), and in our study it is protogynous (Table 1).

Regarding the flowering time, in the climatic conditions from RIFG Pitești, in the spring of 2023, at the Romanian walnut genotypes studied, on average the beginning of flowering of the male flowers took place between the third decade of April and the first decade of May, in time what the beginning of the flowering of female flowers took place in about the same period, but a few days later. Thus, were noticed by early to middle flowering, genotypes, such as 'Şuşiţa', 'Peştişani', 'Novaci', 'Secular', 'Victoria', 'Vlădești', and by medium to late flowering, varieties such as 'Argeşan', 'Ciprian Ion', 'Geoagiu 265', 'Jupânești', 'Mihaela', 'Roxana', 'Sarmis', 'Sibişel 44', 'Velniţa', 'Oraștie' (Table 1). The similar results were reported by Cosmulescu et al. in 2010 for 'Jupânești', 'Orăștie', 'Germisara', 'Roxana' and 'Mihaela' cultivars.

The degree of dichogamy varies from one cultivar to another.

At the Romanian genotypess the degree of dichogamy had an average value of 70.01% ranging from 91.66 at the 'Mihaela' cv. at 30% at the 'Argesan' cv.

The cultivars 'Geoagiu 210', 'Geoagiu 453', 'Novaci', 'Peștișani', 'Roxana', 'Sibișel 50', 'Șușița', 'Valrex', 'Victoria' și 'Vlădești' had the highest dichogamy degree (over 80%) (Table 1).

The coefficient of variability had value of 25.18%, which indicated a high variability of dichogamy degree.



Figure 1. Classification of Romanian genotypes into groups of dichogamy

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#### Table 1. Flowering time of the Romanian walnut genotypes studied and type of flowering (RIFG Pitesti, Romania

2023)						
No.	Genotype	Flowering in male	Flowering in female	Nature of	Degree of	
		flower (day/month)	flowers (day/month)	dichogamy	dichogamy (%)	
Cultivars						
1	Argeșan	24.04 - 30.04	27.04 - 5.05	Protandrous	30.00	
2	Ciprian Ion	30.04 - 12.05	25.04 - 11.05	Protogynous	64.70	
3	Claudia Ioana	29.04 - 11.05	26.04 - 12.05	Protogynous	76.47	
4	Geoagiu 210	26.04 - 10.05	26.04 - 9.05	Homogamous	86.66	
5	Geoagiu 265	29.04 - 11.05	24.04 - 14.05	Protogynous	60.00	
6	Geoagiu 453	27.04 - 9.05	26.04 - 9.05	Homogamous	85.71	
7	Germisara	28.04 - 11.05	24.04 - 11.05	Protogynous	72.22	
8	Jupânești	28.04 - 14.05	22.04 - 10.05	Protogynous	63.16	
9	Mihaela	24.04 - 18.05	30.04 - 11.05	Protandrous	91.66	
10	Miroslava	29.04 - 14.05	23.04 - 11.05	Protogynous	63.16	
11	Novaci	18.04 - 7.05	19.04 - 8.05	Homogamous	89.47	
12	Orăștie	2.05 - 5.05	25.04 - 4.05	Protogynous	10.00	
13	Peștișani	19.04 - 8.05	22.04 - 11.05	Protandrous	80.00	
14	Roxana	21.04 - 8.05	23.04 - 10.05	Protandrous	83.33	
15	Sarmis	22.04 - 9.05	30.04 - 14.05	Protandrous	77.77	
16	Sibișel	22.04 - 4.05	25.04 - 14.05	Protandrous	45.00	
17	Sibişel 252	27.04 - 12.05	23.04 - 8.05	Protogynous	68.75	
18	Sibişel 44	28.04 - 13.05	24.04 - 8.05	Protogynous	66.66	
19	Sibişel 50	22.04 - 9.05	26.04 - 11.05	Protandrous	81.25	
20	Sibișel precoce	24.04 - 4.05	26.04 - 11.05	Protandrous	50.00	
21	Şuşița	18.04 - 9.05	20.04 - 11.05	Protandrous	86.36	
22	Timval	28.04 - 11.05	24.04 - 10.05	Protogynous	70.59	
23	Valcor	23.04 - 9.05	27.04 - 12.05	Protandrous	75.00	
24	Valrex	23.04 - 9.05	26.04 - 11.05	Protandrous	81.25	
25	Velnița	2.05 - 11.05	24.04 - 11.05	Protogynous	50.00	
26	Verisval	27.04 - 12.05	22.04 - 9.05	Protogynous	66.66	
27	Victoria	18.04 - 8.05	20.04 - 11.05	Protandrous	81.82	
28	Vlădești	19.04 - 9.05	22.04 - 11.05	Protandrous	85.00	
Selec	tions					
1	Ciumești 77	23.04 - 9.05	28.04 - 12.05	Protandrous	73.33	
2	M 44-39	23.04 - 10.05	29.04 - 13.05	Protandrous	73.33	
Root	stocks					
1	Dacus	25.04 - 10.05	29.04 - 13.05	Protandrous	73.33	
2	Secular	19.04 - 8.05	24.04 - 11.05	Protandrous	77.77	
Aver	age				70.01	
Standard deviation					17.63	
Coefficient of variation (%)					25.18	

Most of the Moldovan genotypes had a medium to late flowering, except for 'Recea' and 'Schinoasa' cvs. which flowered very early, with the risk of being affected by late spring frosts. The degree of dichogamy had an average value of 53.68% ranging from 85.71 at the 'Codrene' cv. at 9.09% at the 'Recea' cv.

The coefficient of variability had value of 47.52%, indicating a highest variability of dichogamy degree (Table 2).

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 Table 2. Flowering time of the Moldavian walnut genotypes studied and type of flowering (RIFG Pitesti, Romania

 2023)

			2023)		
No.	Genotype	Flowering in male	Flowering in female	Nature of	Degree of
		flower	flowers	dichogamy	dichogamy (%)
1	Cazacu	25.04 - 1.05	29.04 - 7.05	Protandrous	25.00
2	Chișinău	24.04 - 10.05	28.04 - 12.05	Protandrous	80.00
3	Codrene	27.04 - 10.05	26.04 - 9.05	Homogamous	85.71
4	Costiugeni	25.04 - 9.05	29.04 - 13.05	Protandrous	66.67
5	Debriceni	27.04 - 10.05	30.04 - 13.05	Protandrous	71.43
6	Fălești	24.04 - 8.05	28.04 - 12.05	Protandrous	66.67
7	Geamăna	25.04 - 9.05	30.04 - 14.05	Protandrous	60.00
8	Pescianschi	24.04 - 2.05	28.04 - 9.05	Protandrous	33.33
9	Recea	11.04 - 29.04	28.04 - 8.05	Protandrous	9.09
10	Schinoasa	10.04 - 2.05	24.04 - 12.05	Protandrous	38.89
Average					53.68
Standard deviation					22.50
Coefficient of variation (%)					47.52

All three cultivars originated from USA are protandrous, and in terms of flowering, they flowered at the mid to late flowering season (Tabel 3). The similar results regarding the flowering time of 'Chandler' cv. were reported by de Ahi Kosar et al. in 2023. Bobokasvili et al. (2017) reported the same flowering period for 'Hartley' cv.

The degree of dichogamy had an average value of 40.14% ranging from 85.71 at the 'Chandler' cv. at 12.50% at the 'Tehama' cv.

Özcan et al. (2022) reported that 'Chandler' showed protandry. Also, Bujdoso et al. (2020) and Hassani et al. (2020a) confirmed that 'Chandler's' overlapping with staminate bloom was around 10%, and it was protandrous.

Ahi Kosar et al. (2023) reported similar data regarding dichogamy degree of 'Chandler' cv.

The coefficient of variability had value of 9.90%, which indicated a small variability of dichogamy degree (Table 3).

Out of a total of 45 genotypes studied, 29 are protandrous (64.4%), 12 are protogynous (26.6%) and 4 are homogamous (9%) (Fig. 2).

 Table 3. Flowering time of the American walnut cultivars studied and type of flowering (RIFG Pitesti, Romania

 2023)

			2023)		
No.	Genotype	Flowering in male	Flowering in female	Nature of	Degree of
		flower	flowers	dichogamy	dichogamy
1	Chandler	23.04 - 9.05	27.04 - 10.05	Protandrous	85.71
2	Hartley	28.04 - 10.05	8.05 - 16.05	Protandrous	22.22
3	Tehama	24.04 - 10.05	4.05 - 11.05	Protandrous	12.50
Average					40.14
Standard deviation					39.76
Coefficient of variation (%)					9.90
3         Tehama         24.04 - 10.05         4.05 - 11.05         Protandrous           Average					12.50 40.14 39.76 9.90

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Figure 2. Classification of cultivars studied into groups of dichogamy

## **4. CONCLUSIONS**

The results showed that, out of a total of 45 genotypes studied, 29 are protandrous (64.4%), 12 are protoginous (26.6%) and 4 are homogames (9%). Regarding the flowering time, in the climatic conditions from RIFG Pitești, in the spring of 2023, at the walnut varieties studied, on average the beginning of flowering of the male flowers took place between the third decade of April and the first decade of May, in time what the beginning of the flowering of female flowers took place in about the same period, but a few days later. Thus, were noticed by early to middle flowering, varieties such as 'Şuşiţa', 'Peştişani', 'Novaci', 'Recea', 'Secular', 'Schinoasa', 'Victoria', 'Vlădeşti', and by medium to late flowering, varieties such as 'Argeşan', 'Ciprian Ion', 'Geoagiu 265', 'Jupânești', 'Mihaela', 'Roxana', 'Sarmis', 'Sibişel 44', 'Velniţa', 'Orastie'. Also the foreign varieties ('Hartley' and 'Tehama') have noticed by late flowering.

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