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STUDIUL PRIVIND RESURSELE GENETICE DE NUC DIN FLORA SPONTANĂ ŞI CULTIVATĂ A ZONEI DE NORD-EST A ROMÂNIEI

STUDY ON WALNUT GENETIC RESOURCES FROM THE SPONTANEOUS AND CULTIVATED FLORA OF THE NORTHEASTERN AREA OF ROMANIA

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Abstract

The aim of the paper is was to introduce the valuable features of some walnut biotypes selected from the spontaneous and cultivated flora (from the Moldova area) and homologated approved as new cultivars between 1994-2001 that improve the autochthonous walnut assortment with cultivars that have quality fruits, adapted to the climate conditions particular to the North-East of Romania. Analysing the bloom phenophase, it was observed that during the four years of study (2017-2020), the beginning and end of bloom for male and female plants flowers developed between 20th of April and 13th of May. The date when fruits maturated was the earliest for cultivar 'Miroslava' on the 10th of September 2018 and the latest for cultivar 'Anica' on the 25th of September 2020. Analysing the average production over four years, it can be observed that cultivars 'Velniţa' (3.33 kg/tree), 'Anica' (2.93 kg/tree), 'Ovidiu' (2.85 kg/tree) and 'Miroslava' (2.53 kg/tree) have recorded superior values in comparison with the witnesscontrol control cultivar 'Jupâneşti' (1.88 kg/tree). In terms of fruits weight (g), statistically, cultivars 'Miroslava' (14.3 g), 'Anica' (13.1 g) and 'Velniţa' (13.0 g) are highlighted with highly positive significant differences in comparison with the witnesscontrol control cultivar 'Jupâneşti' (12.1 g). In terms of percentage of kernel's weight from the fruit's weight, the 4 four studied cultivars have recorded values over 50%. For each of the studied cultivars ('Anica', 'Miroslava', 'Velniţa' and 'Ovidiu') the shell's colour (the endocarp) is was light brown, having the surface structure light to medium wrinkled and it breaks easily.

Cuvinte cheie: determinări, fruct, însuşiri, nuc, soiuri.
Key words: cultivars, features, fruit, measurements, walnut.

1. Introduction

The walnut tree, one of the oldest fruit-growing trees species is highly important economically and socially due to the fruits' nutritive value, superior quality of the wood and the possibility to use the other parts of the tree (leaves, bark, endocarp, shoots) as raw materials in the chemical and pharmaceutical industries. Furthermore, it is a highly effective decorative and eco-ameliorative species (Cociu, 2007).

Walnut crops have a long tradition in the fields of Romania. Taking into consideration the high prices and the increasing demands of the international markets, walnut crops have the advantage of producing fruits with a high potential for capitalization (Botu and Achim, 2001).

A series of genetic breeding programmes have been launched for the walnut species in the past 45 years to obtain cultivars with quality fruits (Botu et al., 2001; Cociu, 2003).

In 1977, when Research Station for Fruit Growing (RSFG) Iaşi was founded, the foundations have been laid for a modern activity of research and development for the walnut crop, aiming to define an assortment that was adequate to the NE area of Romania. Since 1979, the walnut assortment improvement activities increased which led to identifying valuable walnut trees biotypes within the rich walnut trees collection from the spontaneous and cultivated flora from the Moldova region (NE of Romania).

The aim of this paper was to introduce the valuable traits of specific walnut trees biotypes selected from the spontaneous and cultivated flora (from the Moldova region) and approved as new cultivars between 1994-2001 that improve the indigenous walnut assortment with cultivars of early, medium and late maturation, quality fruits, all adapted to the specific climate conditions of the NE of Romania.

2. Material and methods

In 1979, the Research Station for Fruit-Growing (RSFG) Iaşi initiated the identification and marking of the valuable types of walnut trees from the counties of Iaşi, Botoşani and Vaslui. The studied walnut trees came from natural propagation and they all had their own root system. To identify and mark the

walnut trees, a list of characteristics was required: the vigour of the trees, the precocity, resistance to frost and diseases, productivity and fruits quality (size described by the average weight of the fruit in grams, the fruit's aspect, the nature of the bark's surface, it's thickness and hardness, the walnut shell suture, kernel percentage and its quality).

For the selected walnut biotypes (the ones that fit the main assortment breeding objectives), at least three years of observations took place at the place of origin, then they were grafted in nursery and planted in trial field at RSFG Iaşi.

The studies were carried out between 2017-2020 using as research material four walnut cultivars ('Miroslava', 'Velniţa', 'Ovidiu', 'Anica') all in their 10th year since planting, all grafted on *Juglans regia* L. as seedlings rootstock. The comparison of the genotypes was performed against the controlcontrol cultivar 'Jupâneşti'.

The trial was placed linearly, in three rows of five trees each cultivars, at a distance of 8×10 m (125 trees/ha), without irrigation system. On the trees row, the soil was mulched with biodegradable material and between the trees rows the soil was grassed. The pest and diseases control was performed in accordance with the received advices and the crop technology was specific to walnut cropping.

Observations and measurements were performed in the experimental plantation for: trees vigour (trunk cross section area, TCSA cm^2), resistance to frost (Cociu and Oprea, 1989), the main growing and fructification phenophases (Fleckinger, 1960). Measurements and determinations (in accordance with the UPOV TG/125/7 questionnaire from 2017) were performed for the physical and morphometrical traits of the fruits (fruits weight and size, fruits shape index, number of walnuts per kg, kernel percentage from the fruit weight, kernel g/fruit, endocarp and kernel colour, the thickness and structure of the endocarp surface, fruit shape).

The productivity was determined based on the production of fruits kg/tree (Cociu and Oprea, 1989).

The experimental data was interpreted statistically by analysing the variance.

3. Results and discussions

The trunk cross section area (TCSA) in the 10th year since planting (2020) was between 80.1 cm^2 ('Ovidiu') and 100.0 cm^2 ('Anica'). Statistically analysing this parameter, it was noticed that cultivars 'Ovidiu' (80.1 cm^2) and 'Velniţa' (83.3 cm^2) recorded negative distinct significant differences in comparison with the controlcontrol cultivar 'Jupâneşti' (93.3 cm^2). Cultivar 'Anica' (100.0 cm^2) recorded positive distinct significant differences and cultivar 'Miroslava' (98.5 cm^2) recorded positive significant differences compared with control cultivar (Table 1).

In terms of resistance to frost for the studied cultivars, in 2017, 2018, 2019 and 2020 at the end of March – beginning of April when the walnut trees starts the vegetation, the recorded minimum temperature was between -11.9 °C and -2.5 °C. Under these weather conditions, the flower buds become sensitive and flower parts more damaged leading to partially compromising the fruits production. These results are in accordance with other research for the walnut trees cultivars (Grădinariu et al., 1998; Rodrigo, 2000; Botu et al., 2010). Statistically, cultivars 'Miroslava' (11.0 %) and 'Velniţa' (12.5 %) recorded negative significant differences in comparison with the controlcontrol cultivar 'Jupâneşti' (27.3 %) and cultivars 'Anica' (21.2 %) and 'Ovidiu' (24.1 %) recorded non-significant differences in comparison with the controlcontrol cultivar. Cultivars 'Anica', 'Miroslava', 'Ovidiu' bear fruits from terminal buds, while cultivar 'Velniţa' bears fruits on the lateral buds as well (Table 2).

The phenophases of the fructification organs are specific to the biology of each species and the triggering date along with their duration are linked to the climatic conditions of each year (Darbyshire et al., 2012) (Tabel 3).

The beginning of bloom was triggered the earliest in 2017 and 2020 and the latest in 2018 and 2019.

Over the four years of study (2017-2020), the bloom phenophase took place between the 20th of April and the 13th of May (the beginning and end of bloom in the male flowers took place the earliest on the 20th of April 2017 and the 1st of May 2019 for cultivar 'Anica' and the latest on the 5th of May 2018 and the 13th of May 2019 for cultivar 'Velniţa'. The beginning and end of bloom in the female flowers took place the earliest on the 26th of April 2019 and 2nd and 3rd of May 2019 for cultivars 'Miroslava' and 'Anica' and the latest on the 2nd of May 2017 and 11th of May 2017 for cultivars 'Jupâneşti', 'Velniţa' and 'Ovidiu'). The duration of bloom was between 6 six days for cultivar 'Miroslava' and 12 days for cultivars 'Anica' and 'Ovidiu'.

The earliest fruit maturation date was on the 10th of September 2018 in 'Miroslava' cultivar and the latest on the 25th of September 2020 in 'Anica' cultivar (Fig. 1). The number of days between the end of bloom and maturation was between 128 days for cultivar 'Velniţa' and 143 days for cultivar 'Anica'. In comparison with the witnesscontrol control cultivar 'Jupâneşti', for cultivars 'Miroslava' and 'Velniţa', this phenophase takes place one week earlier, for cultivar 'Ovidiu' it takes place around the same time with

the witnesscontrol control cultivar and for cultivar 'Anica' it takes place almost two weeks later than the witnesscontrol control cultivar (Table 3, Fig. 1).

The production of fruits differs between cultivars and between years, being negatively influenced by the climatic conditions of the studied years, when the late spring frosts and the long drought from the summer period generated partial loss of the fruits production.

Analysing the average production over four years (years VII-X since planting), statistically, it was noticed that cultivar 'Velniţa' (3.33 kg/tree) recorded positive distinct significant differences in comparison with the controlcontrol cultivar 'Jupâneşti' (1.88 kg/tree), cultivars 'Anica' (2.93 kg/tree) and 'Ovidiu' (2.85 kg/tree) recorded positive significant differences and cultivar 'Miroslava' (2.53 kg/tree) recorded non-significant differences in comparison with the controlcontrol cultivar (Table 4).

The weight of the walnut and the kernel percentage are the most important characteristics that influence the quality of a cultivar fruit. The larger the kernel percentage and the lowest the walnut shell/kernel ratio, the higher the value of the fruit gets (Botu et al., 2001).

The average weight of the fruits was between 12.0 g ('Ovidiu') and 14.3 g ('Miroslava'), resulting 70 - 83 fruits/kg. Statistically, cultivars 'Miroslava' (14.3 g), 'Anica' (13.1 g) and 'Velniţa' (13.0 g) recorded very significant positive differences in comparison with the controlcontrol cultivar 'Jupâneşti' (12.1 g). Cultivar 'Ovidiu' (12.0 g) recorded non-significant differences (Table 5).

The kernel content per fruit was between 6.4 g ('Ovidiu') and 7.3 g ('Miroslava'). Statistically analysing this parameter, it was noticed that cultivar 'Miroslava' (7.3 g) recorded very significant positive differences in comparison with the controlcontrol cultivar 'Jupâneşti' (6.3 g), cultivar 'Anica' (6.6 g) recorded significant positive differences and cultivars 'Velniţa' (6.5 g) and 'Ovidiu' (6.4 g) recorded non-significant differences in comparison with the control cultivar (Table 5).

The main feature for the fruit is the kernel percentage from its average weight (Botu et al., 2001). In this study, this parameter recorded values of 50.1 % ('Velniţa') and 53.2 % ('Ovidiu'). The largest kernel percentage was recorded in cultivar 'Ovidiu' (53.2 %) with very significant positive differences in comparison with the control cultivar 'Jupâneşti' (52.0 %) (Table 5).

The fruits dimensions (H, D and d) for the measured walnuts were different based on the walnut cultivar and fruit shape (table 6). The walnuts with a calibre larger than 30-32 mm are for mass consumption (Botu et al., 2001). Based on the average of the equatorial diameters (D+d/2) whose values are between 31.7 ('Ovidiu') and 37.5 ('Velniţa'), all studied cultivars meet these requirements for the size of the walnuts, corresponding for mass consumption. The shape index was between 104 ('Anica') and 130 ('Ovidiu') (Table 6).

According to the criteria set by Bordeianu et al. (1967), the values of the shape index below 110 are specific to spheroid shapes; the values between 110 and 125 are specific to ovoid shapes and the values over 125 are specific to elongated ellipsis shapes.

All the studied cultivars ('Anica', 'Miroslava', 'Velniţa' and 'Ovidiu') have a light brown shell colour (endocarp), with slightly to moderately creased external structure and it cracks easily (Table 7).

The walnut kernel tegument colour is an important characteristic for both walnut fruits and walnut kernels commercial purposes. The walnut kernel tegument colour is dependent on genotype, environment conditions and harvesting time (Cosmulescu & Botu, 2012a).

4. Conclusions

The walnut cultivars created at RSFG Iaşi were highlighted by good resistance to the late spring frosts, fructification on lateral branches ('Velniţa'), earliness ('Miroslava', 'Velniţa'), productivity, high quality of the fruits (the fruits are good-looking, with an average weight over 12 g, thin shell, light colour kernel and kernel yield over 50%).

5. Acknowledgements

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Tables and Figures

Table 1. Data regarding trees vigour in walnut tree cultivars in their year X since planting

Cultivar	Trunk section area (cm²) in 2020				
	Trunk annual growth (cm²)	Trunk cross section area (cm²)	Calculated in comparison with the control cultivar		
			%	Difference	Significance
Anica	12,1	100.0	107.2	+6.7	++
Miroslava	10.2	98.5	105.6	+5.2	+
Jupâneşti (control)	14,2	93.3	100	-	-
Velniţa	11.0	83.3	89.3	-10.0	000
Ovidiu	9.6	80.1	85.6	-13.2	000

*DL 5% =4.3 cm^2; DL 1% = 6.0 cm^2; DL 0,1% = 8.5 cm^2; + - positiv significant differences; ++ - positive distinct significant differences; 000 – very significant negative differences.

Table 2. The tree's characteristics in the studied walnut tree cultivars (RSFG Iaşi; 2017-2020)

Cultivar	Damaged flower buds (%)*	Crown shape	Fructification type	Bloom type
Anica	21.2^{ns}	improved vase-like	terminal	protandrous (♂)
Miroslava	11.0^{000}	improved vase-like	terminal	protogynous (♀)
Jupâneşti (control)	27.3	improved vase-like	terminal	protandrous (♂)
Velniţa	12.5^{000}	improved vase-like	terminal and lateral	protogynous (♀)
Ovidiu	24.1^{ns}	improved vase-like	terminal	protandrous (♂)

*DL 5% =6,5 %; DL 1% = 9.2 %; DL 0,1% = 13.0 %; ns – non-significant differences; 000 – very significant negative differences.

Table 3. The main fructification phenophases in walnut cultivars in their years VII-X since planting (RSFG Iaşi; 2017-2020)

Cultivar	Bloom				Bloom duration (days)	Maturation date	No. of days between end of bloom and maturation
	Male flowers (♂)		Female flowers (♀)				
	Beginning	End	Beginning	End			
Limit dates (the earliest-the latest):							
Anica	20.04-27.04	01-08.05	26.04-01.05	03.05-10.05	8-12	22-25.09	139-143
Miroslava	29.04-03.05	04-13.05	26.04-01.05	02.05-10.05	6-11	10-15.09	129-132
Jupâneşti (control)	25.04-28.04	03-08.05	28.04-02.05	05.05-11.05	8-11	16-19.09	132-135
Velniţa	30.04-05.05	07-13.05	27.04-02.05	05.05-11.05	8-10	12-15.09	128-131
Ovidiu	25.04-27.04	03-07.05	27.04-29.04	07.05-11.05	9-12	17-19.09	133-135

Table 4. Fruits production in walnut cultivars in their years VII-X since planting (SCDP Iaşi; 2017-2020 average)

Cultivar	Average production (kg/tree/year):				Average production (2017-2020)	
	2017	2018	2019	2020	kg/tree*	t/ha**
Anica	0.6	5.6	3.2	2.3	2.93^{+}	0.37
Miroslava	0.9	4.3	2.0	2,9	2.53^{ns}	0.32
Jupâneşti (control)	0.3	2.6	1.8	2.8	1.88	0.24
Velniţa	1.3	5.1	3.4	3.5	3.33^{++}	0.42
Ovidiu	1.3	5.1	2.4	2.6	2.85^{+}	0.36

*DL 5% =0.93 kg/tree; DL 1% = 1.31 kg/tree; DL 0,1% = 1.85 kg/tree; ns – non-significant differences; + - positive significant differences; ++ - positive distinct significant differences;
** Density: 125 trees/ha.

Table 5. Physical traits in the studied walnut cultivars (RSFG Iaşi; 2017-2020 average)

Cultivar	Fruit's average weight (g)*	No. of walnuts per kg (items)	Content of kernel per fruit (g)	Kernel from fruit's weight (%)
Anica	13.1^{+++}	76^{00}	6.6^{+}	50.3^{000}
Miroslava	14.3^{+++}	70^{000}	7.3+++	51.2^{00}
Jupâneşti (control)	12.1	83	6.3	52.0
Velniţa	13.0^{+++}	77^{00}	6.5^{ns}	50.1^{000}
Ovidiu	12.0^{ns}	83	6.4^{ns}	53.2^{+++}
Dl 5%	0.4 g	3.8 items	0.3 g	0.5 %
DL 1%	0.6 g	5.3 items	0.4 g	0.8 %
DL 0.1%	0.9 g	7.5 items	0.5 g	1.1 %

* ns – non-significant differences; + - positive significant differences; +++ - very significant positive differences; 00 – negative distinct significant differences; 000 – very significant negative differences.

Table 6. Morphometric data (dimensions) and fruits shape in walnut cultivars (RSFG Iaşi; 2017-2020 average)

Cultivar	Fruits dimensions (mm)			(D+d)/2 (mm)	Shape index $\frac{H \times 100}{(D+d)/2}$	Fruit shape
	H	D	d			
Anica	36.8	34.2	36.3	35.3	104	ovoid, symmetric
Miroslava	42.3	35.5	33.4	35.0	123	round-ellipsis
Jupâneşti (control)	44.0	30.2	29.2	29.7	148	ovo-conical
Velniţa	40.2	37.8	37.2	37.5	107	ovoid, symmetric
Ovidiu	41.3	32.6	30.7	31.7	130	ellipsis

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Table 7. Physical and quality characteristics in the studied walnut cultivars (RSFG Iaşi)

Cultivar	Endocarp			Kernel tegument colour[4]
	Colour[1]	Thickness[2]	Surface structure[3]	
Anica	2	3	2	2
Miroslava	2	1	1	2
Jupâneşti (control)	1	2	1	3
Velniţa	2	3	2	2
Ovidiu	2	2	2	2

[1] - endocarp colour mark on a scale of 1-3: 1= yellow; 2= light-brown; 3= moderate-brown (***, 2017);
[2] - endocarp thickness mark on a scale of 1-3: 1= very thin; 2= thin; 3= moderate (***, 2017);
[3] - endocarp surface structure mark on a scale of 1-2: 1= slightly creased; 2= moderately creased (***, 2017);
[4] - kernel tegument colour mark on a scale of 1-3: 1= white; 2= yellow white; 3= yellow (***, 2017).

Cultivar	September (day)															
	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Miroslava																
Velniţa																
Jupâneşti																
Ovidiu																
Anica																

Fig. 1. Fruit's maturation schedule in the studied cultivars