

EVALUATION OF FLOWERING TIME AND SOME REPRODUCTIVE TRAITS OF ROMANIAN WALNUT GENOTYPES

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Abstract

The aim of this paper was to evaluate some autochthonous walnut genotypes in the Romanian North Eastern area conditions. Studies were done in 2016-2018, having as research material four walnut genotypes ('Miroslava', 'Anica', 'Velnița' and 'Ovidiu') which were in the VIIIth year after planting grafted on Juglans regia L. as rootstock. The climate conditions, bloom for both male and female flowers period, late frost resistance, the tree vigor through trunk cross-section area (cm²), tree height (cm) and number of the young shoots were analyzed. Regarding the dichogamy, conducted research showed that 'Miroslava' and 'Velnița' are protogynous genotypes. The beginning of flowering in female flowers was depending on the climatic conditions in the study period 2-3 days before the male flowers. 'Anica' and 'Ovidiu' are protandrous genotypes, the male flowers starting to bloom on average three days before the female flowers. The weakest vigor of the tree showed 'Ovidiu' (30.2 cm² TSA) and 'Miroslava' (42.6 cm² TSA), but as the length of the young shoots, the highest values were registered at 'Velnița' (96.2 cm) genotypes.

Keywords: bloom, shoots, genotype, vigor, walnut

1. INTRODUCTION

On the Romanian territory, among the numerous cultivated fruit species, the walnut has a millenary tradition (Botu et al., 2010, Sîrbu et al, 2017). Until the beginning of the 20th century, it formed forests and plantations spread in the counties of Gorj, Vâlcea, Dâmbovița, Prahova, Bacău, Neamț, Iași, Suceava. The permanent interest in the spread of walnut cultivation was mainly aimed at improving the current assortment in order to find varieties suitable for intensive crops (Sadullaevich & Boshlarovich, 2021) According to FAO Data Base, in Romania, the area harvested with walnuts increased in the period 2018-2020 by 16.8%, respectively from 1590 ha to 1910 ha, the total production of walnuts reaching 51.600 tons in 2020. This is because walnut orchards are an important source of income for farmers (Zang et al., 2014).

The main objective of the present study is to evaluate the influence of environmental factors on the vegetative parameters of the walnut species in the growing conditions of North-Eastern Romania.

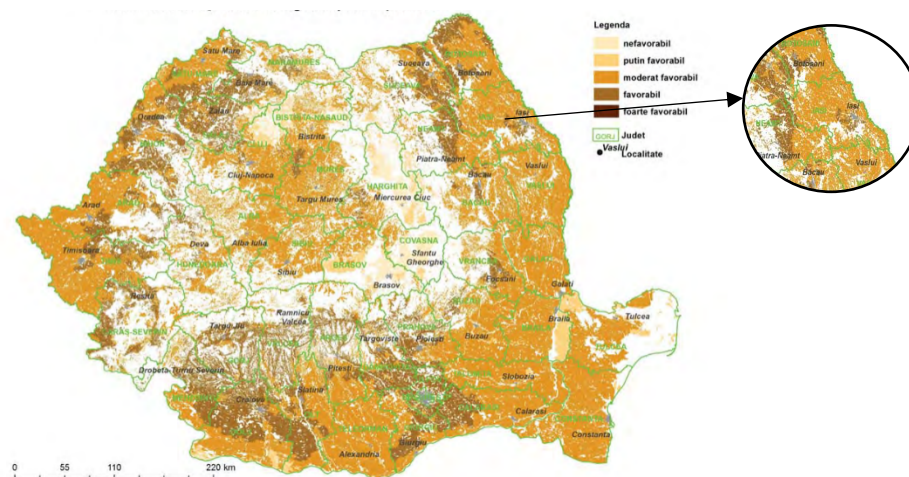


Fig. 1. Map of the suitability of agricultural land for walnut and the culture area from NE Romania
(Source: Coman et al., 2014, p.81)

2. MATERIALS AND METHODS

2.1. Materials

This study was performed in the period 2016-2019, at Research Station for Fruit Growing (RSFG) Iași, having as research material four autochthonous genotypes of walnut: ‘Miroslava’, ‘Velnița’, ‘Ovidiu’ and ‘Anica’. All these genotypes were created and approved from the walnut breeding program of RSFG Iași. The experimental fields were placed in the Sârca valley, in the area of the Bahlui river hydrographic basin. All the genotypes are grafted on *Juglans regia* L. seedlings as rootstock and planted on a mezorelief with a slightly sloping plateau and includes predominantly cambic chernozem soils with good natural drainage (Dumitru et al., 2009).

The walnut genotypes were planted in 2010 in an experimental linearly design with three repetitions of three trees at 8 x 10 m distances. On the rows with trees, the soil was mobilized with the help of the feeler disc and between the rows it was grassed and mown two time a year. The maintenance of the experience regarding the control of diseases and pests was carried out according to the crop technology specific to walnut.

2.2. Methods

Observations were made in the field through the three years for each phenophase. The following biology characteristics of flowering in walnut genotypes have been recorded: the beginning of flowering in ♀ flowers (Ef), the end of flowering in ♀ flowers (Gf), the beginning of flowering in ♂ flowers (Bm), the end of flowering in ♂ flowers (Gm2), fruit ripening (O) and leaf fall (Dz). Also, the sum of active temperature during the fruiting phenophase was calculated for each cultivar. During the study, resistance to limiting factors was also assessed. Thus, the resistance of walnut fruit buds to frost was also studied by harvesting 100 fruit buds from different parts of the crown (the base, center and upper part of the crown), their sectioning and the calculation of the percentage of destroyed buds.

During the three years of study, the vigor of the trees was analyzed with the following aspects: trunk cross sectional area (cm²), the height of the tree (cm), the average length of the annual branches (cm) and the amount of branches on the tree (pcs). The length of annual branches and the tree’s height (H) were determined with the tape measure and the trunk cross sectional area was determined by measuring the thickness of the trunk with a calliper on two perpendicular directions 30 cm high from the grafting point. The trunk cross-sectional area of tree was calculated by using formula $TCSA = Girth^2/4$ (Westwood et al., 1963)

The experimental data obtained were statistically interpreted by using the method of multiple comparisons (Duncan test) and coefficient of variation.

2.2.1. Climatic conditions from 2016-2019 at RSFG Iași

Although the walnut can grow on a vast area, large and constant productions are relatively few. This derives from the influence of ecological factors that have a particularly important role on culture and implicitly on production (Cosmulescu et al, 2010). Meteorological elements act simultaneously with technology on the plant's physiological processes. In the walnut culture systems, knowledge of the requirements of the walnut in relation to climatic and edaphic factors is essential (Dehghan et al, 2010).

The climatic conditions of the NE area of Romania during 2016-2019 were favorable for the walnut plantation. As an essential element throughout the year, the average temperature in the hottest month during the study period was in 2016 and did not exceed 22.6°C. Also, the minimum temperature was in January of 2017 of -4.9°C.

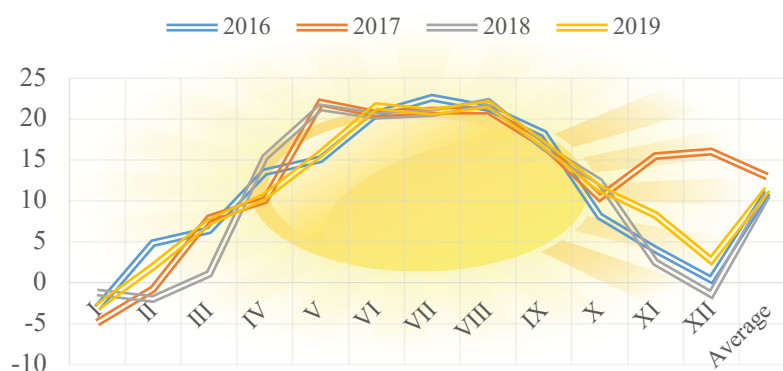


Fig. 2. Average monthly temperatures in the period 2016-2019 (RSFG Iași)

In terms of water requirements, specialized literature places the walnut in the group of species with moderate requirements, developing properly in areas where the annual precipitation amounts to 600-700 l/m². In the period 2016-2019, the amount of annual precipitation varied between 459 l/m² (2019) and 1045.8 l/m² (2017).

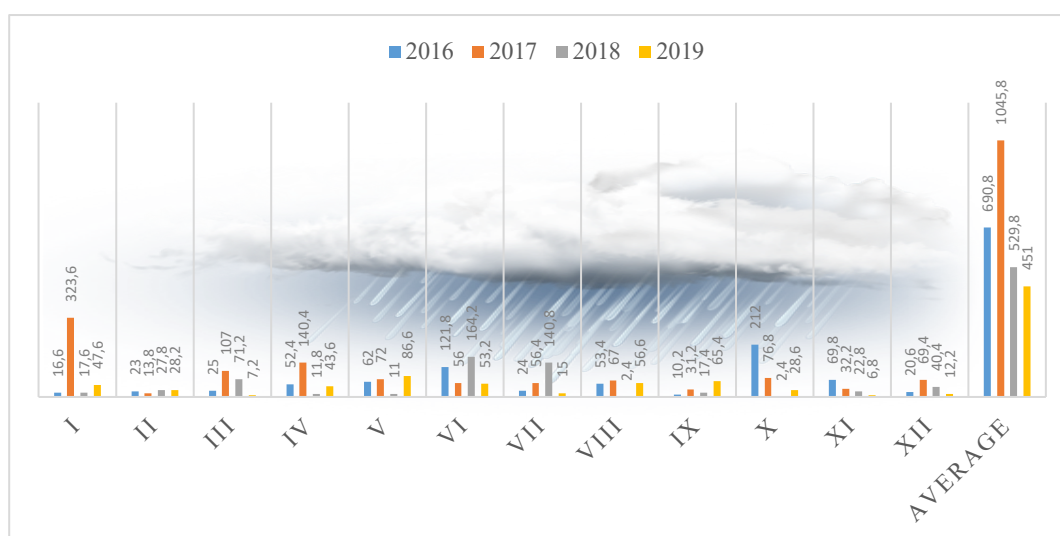


Fig. 3. Monthly rainfall in the period 2016-2019 (RSFG Iași)

3. RESULTS

The study was carried out in order to made a compare between the four walnut cultivars, created at RSFG Iași and to predict the degree of adaptability to the existing climatic conditions. During the study, the annual average temperature was 10.87°C, with a deviation from the thermal normal of only 1.3°C, while the average amount of rainfall over the three years was 755 mm. Vegetation period and time of flowering are specific biological traits of walnut (*Juglans regia* L.) and depend on the genotype of the cultivar and the climatic conditions of the year, under which it is grown (Germain et al., 1999).

Table 1 shows that the four walnut cultivars have a close flowering period for both female and male flowers. Depending on flowering time, walnut cultivars can be grouped into 4 classes: the early class (April 20-30), semi-early class (May 1-5), semi-late class (May 6-10) and late class (after May 10) (Cosmulescu et al., 2010). The walnut cultivars studied have an early flowering between 22 and 26 April.

As for the fruit, the 'Miroslava' cultivar was noted as having the earliest ripening of the fruit. The longest vegetation period from beginning of flowering to the leaf fall was necessary for the 'Ovidiu' cultivar, with an average need of 214 days. The minimum value of the number of vegetation days was registered for the 'Velnița' cultivar, with 189 days required. The statistical differences between the four varieties were significant only between the 'Velnița' cultivar and the other three cultivars. In our study, the time of leaf fall were observed as 21 October ('Velnița') to 25 October ('Ovidiu' and 'Anica'). The earliest leaf fall times among Romanian cultivars were observed to the 'Velnița' and 'Miroslava'.

Cultivar	The beginning of flowering in ♀ flowers (Ef)	The end of flowering in ♀ flowers (Gf)	The beginning of flowering in ♂ flowers (Bm)	The end of flowering in ♂ flowers (Gm ₂)	Fruit ripening	Leaf fall	Vegetation period (days)
Miroslava	24 IV	3 V	26 IV	2 V	10 IX	23 X	197.00 ^a
Velnița	24 IV	2 V	26 IV	4 V	15 IX	21 X	189.00 ^b
Ovidiu	25 IV	1 V	22 IV	30 IV	12 IX	25 X	214.67 ^a
Anica	26 IV	3 V	24 IV	1 V	16 IX	25 X	198.00 ^a

*Different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test.

Table 1. Phenological stages of Romanian walnut genotypes (Iași, 2016-2019, n=3)

The variability of climatic conditions from one year to another changes the triggering of the organogenesis of female and male flowers. In the case of the chosen cultivars, the duration of flowering of the two types of flowers is different, depending on the cultivar and the climatic conditions of the year (Cociu, 2007). Table 2 shows the number of days and the sum of the active temperature degrees required for the phenological stages of flowering and fruiting.

The female flowers of the walnut cultivars studied recorded average values between 6 ('Miroslava') and 8.3 days ('Velnița') from the beginning to the end of flowering and a maximum temperature of 375.6°C, with significant differences between cultivars. The male flowers, on the other hand, had a flowering duration from 5.33 ('Ovidiu') to 9 days ('Miroslava'). The ripening of the fruit took place when the temperature reached between 3070.00 °C ('Miroslava') and 3380.60°C ('Anica') at the end of the flowering of the female flowers.

Statistically, the differences were significant between cultivars 'Anica' and 'Ovidiu' with 'Miroslava' and 'Velnița'.

Cultivar	Phenological stage					
	The beginning of flowering in ♀ flowers (Ef)- The end of flowering in ♀ flowers (Gf)		The beginning of flowering in ♂ flowers (Bm) -The end of flowering in ♂ flowers (Gm ₂)		The end of flowering in ♂ flowers (Gf) - Fruit ripening (Mf)	
	No. days	Σ °C	No. days	Σ °C	No. days	Σ °C
Miroslava	6.00 ^c	330.60 ^{ab}	9.00 ^a	353.10 ^a	127.33 ^b	3070.00 ^b
Velnita	8.33 ^a	375.60 ^a	8.00 ^{ab}	330.50 ^b	136.00 ^{ab}	3162.50 ^b
Ovidiu	8.00 ^{ab}	298.80 ^b	5.33 ^b	321.20 ^b	135.00 ^{ab}	3320.70 ^a
Anica	7.33 ^b	307.20 ^b	7.33 ^{ab}	353.43 ^a	143.33 ^a	3380.60 ^a

*Different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test.

Table 2. Number of days and sum of active temperature (above 10°C) during the fruiting phenophase of Romanian walnut genotypes (Iași, 2016-2018, n=3)

The extension of walnut cultivation in Romania is limited to some areas due to the incidence of low temperatures in winter (-27 to -31 °C), bacterial attack, lack of irrigation in most cases and high technological demands of intensive walnut orchards (Botu et al., 2012). Low temperatures during the flowering period have negative effects on the stigmas and at temperatures of maximum - 3°C, both male and female flowers, but also shoots and leaves can be destroyed (Kaur et al., 2020)

Thus, the percentage of male and female flowering buds affected by spring frost was monitored and presented in Table 3. The most affected cultivar was 'Ovidiu', with 60% female and 40% male flowers affected. The highest resistance to low spring temperatures was recorded for the cultivars 'Miroslava' and 'Velnita' with 10-15% affected flowers. The statistical differences were significant.

Cultivar	Affected flowers	
	♀	♂
	(%)	(%)
Miroslava	15.00 ^c	10.00 ^c
Velnița	15.00 ^c	15.00 ^c
Ovidiu	60.00 ^a	40.00 ^a
Anica	30.00 ^b	25.00 ^b

*Different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test.

Table 3. The late spring frost resistance of the studied Romanian walnut genotypes (Iași, 2016-2018, n=3)

Growth vigor, branching and crown habit are very important characteristics of the studied cultivars (Table 4 and Table 5). During the three years, the walnut cultivars had a different growth of the trunk section which varied from 24.00 cm² ('Ovidiu') to 57. 63 cm² ('Velnita'). The most vigorous cultivar

proved to be ‘Velnita’, having the highest height compared to the other cultivars. The number of branches grafted/ tree varied between 30.67 (‘Ovidiu’) and 58.20 (‘Velnita’) while the length had minimum values to the ‘Anica’ cultivar (58.21 cm). All the biometric measurements had significant differences between cultivars.

Cultivar	TCSA	Tree height	Length of grafted branches	Number of branches grafted / tree
	(cm ²)	(cm)	(cm)	(pcs.)
Miroslava	49.00 ^{ab}	316.00 ^b	69.61 ^{ab}	54.42 ^a
Velnița	57.63 ^a	395.80 ^a	96.21 ^a	58.20 ^a
Ovidiu	24.00 ^b	280.00 ^{bc}	69.40 ^{ab}	30.67 ^b
Anica	30.17 ^{ab}	271.55 ^c	58.21 ^b	35.50 ^b

*Different letters correspond with the significant statistical difference for $P \leq 5\%$, Duncan test.

Table 4. Biometric measurements of the studied Romanian walnut genotypes (Iași, 2016-2019, n=3)

In Table 5 is evaluated the calculation of the relationship between the movements of two random variables of growth parameters, TCSA and tree height. On these walnut cultivars, the TCSA and tree height having a positive covariance with values between 17.95% for tree height and 39.19 % for the TCSA parameter. Covariance is calculated with the correlation between the two random variables by the standard deviation of each variable. Thereby, the standard deviation recorded values between 15.75% for TCSA parameter and 56.68% for the tree height.

Cultivar	TCSA	Tree height
	(cm ²)	(cm)
Miroslava	49.00	316.00
Velnita	57.63	395.80
Ovidiu	24.00	280.00
Anica	30.17	271.55
Min	24.00	271.55
Max	57.63	395.80
Average	40.20	315.84
STDEV	15.75	56.68
COVAR S%	39.19	17.95

Table 5. Standard deviation and covariance of growth parameters of the studied Romanian walnut genotypes (Iași, 2016-2019)

4. CONCLUSIONS

All four walnut cultivars created within RSFG Iași are adapted to the climatic conditions in all areas of Romania, but they are also suitable for all areas with similar climatic conditions. The cultivar that stood out was ‘Velnita’, with a higher growth rate and resistance to late spring frosts.

This large variation in phenophase triggering and pomological characteristics of the walnut cultivars indicates a high potential in the selection of new genotypes that were investigated in this study. The selected cultivars are promising and they will be further exploited by walnut breeding programs for their tree and fruit characteristics.

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