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DETERMINATIONS OF THE TREE VIGOR AND ANNUAL GROWTH AT SOME WALNUT GENOTYPES FROM THE ROMANIAN NORTH-EASTERN AREA

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Abstract
The aim of this paper is to present behaviour of some autochthonous and foreign walnut cultivars in the Romanian North Eastern area conditions. Studies were done in 2016, having as research material that 14 walnut genotypes which were in the VIth year after planting grafted on Juglans regia L. *as rootstock. Observations and measurements were done to find the behaviour of the plants in the growth process. The climate factors, the tree vigor through trunk cross-section area (cm^2), tree height (cm), increases (cm) and number of the young shoots were analyzed. The weakestvigor of the tree showed 'Sibişel' (10.9 cm^2), 'Ovidiu' (11.3 cm^2), 'Geoagiu 65' (15.5 cm^2), 'Germisara' (16.7 cm^2), 'Jupâneşti' (17.1 cm^2) and 'Anica' (19.5 cm^2) with very significant negative differences compared with average variant as control. As the length of the young shoots, the highest values were registered at 'Miroslava' (106 cm) and 'Velniţa' (94 cm) genotypes.*

Keywords: annual increases, genotype, vigor, walnut.

1. INTRODUCTION

The walnut tree, one of the oldest fruit-growing tree species, has a particular economic and social importance, due to the fruits' nutritive value, wood's superior quality, the use of the other organs of the tree (leaves, bark, endocarp, sprouts) as raw material for the chemical and pharmaceutical industry. Moreover, it is a decorative and eco-breeding species of a great effect (Cociu, 2007).The walnut crop has a long tradition on the territory of Romania and it has the advantage of producing fruits with a high potential for capitalization, taking into consideration the high prices and the increasing demands of the international market (Botu and Achim, 2001).In the last years new walnut orchards have been established with introduced foreign cultivars or promising native cultivars selected from different regions of Romania, more than 40% from all fruit trees species being walnut (Chitu and Coman, 2014).The *Juglans regia* L. species can be found spread all over the country in organised plantations or as individual plants, establishing a valuable germplasm fond that can be utilized in obtaining new bred cultivars.

To obtain cultivars with qualitative fruits, a series of genetic breeding programmes have been launched in the last 40 years for the walnut species (Botu et al., 2001; Cociu et al., 2003).Beginning with 1977, at the same time with the start of Research Station for Fruit Growing RSFG Iaşi, it was founded a modern activity of research and development for the walnut crop, with interests concerning the establishment of an assortment adequate to the NE area of Romania. Following the

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research done since 1979, 25 valuable walnut biotypes were traced, from which the first to be homologated and patented as new cultivars were the 'Miroslava', 'Velnița', 'Anica' and 'Ovidiu' cultivars from the Moldova area (Petre and Rominger, 1996).Besides these, the introduction of foreign cultivars was also taken into consideration to accomplish the assortment with valuable cultivars for breeding in production.
The paper presents aspects concerning the influence of environmental factors recorded in 2016, in the Iaşi area, over the growing of the trees for some autochthonous and foreign walnut cultivars in the crop conditions from the NE area of Romania.

2. MATERIALS AND METHODS

The experiment was organised in 2011, on the territory of RSFG Iaşi, in a locality named Sârca. The land on which the plantation was founded is placed in the Jijia-Bahlui river basin and the soil is typical cambic, with a big depth of the groundwater (10 m). The area is characterized by a multiannual average temperature of 9.6°C (average on 15 years) and the multiannual rainfall of 524.6 mm (table 1).
The studies were done in 2016, having as research material 14 genotypes of walnut from which eight autochthonous ones ('Anica', 'Ovidiu', 'Velnița', 'Miroslava', 'Jupâneşti', 'Sibişel', 'Germisara', 'Geoagiu 65') and six from the international assortment ('Bortko', 'Danirenko', 'Schinoasa', 'Recea', 'Făleşti'and 'Codrene'), all being in the VIth year from plantation, grafted on *Juglans regia* L. The comparison of genotypes was done with the average of the variants.
The experiment was linearly placed, in three repetitions of three trees at 8x10 m distance, without an irrigation system. On the row with trees, the soil was mulched with biodegradable material and between the rows of trees, it was grassed and mown two times a year. The control of diseases and pests was done in accord with the received warnings and the crop technology was the one particular to the walnut crop.
The observations and the measurements that have been done targeted the behaviour of the plants in the growing period. The meteorological factors have been analyzed and observations and determinations have been done concerning the trees' vigor (trunk section surface, cm^2), trees' height (cm), annual shoots length (cm) and the number of shoots per tree (items). The surface of the trunk's section was determined by measuring the trunk's thickness with the callipers and the collected data was transformed in cm^2. The trees' height and the annual shoots length was determined by measurement.
The experimental data was interpreted statistically through analysis of the variance.

3. RESULTS AND DISCUSSIONS

Besides the hereditary traits that the walnut cultivars posses, elements of climate and technology act simultaneously on the biological processes. Walnut is a species with moderate demands for water, but in the phenophase of intense growth of the shoots until the forming of the terminal bud (process that marks the termination of the shoot growth) which takes place during May, June and the first half of July, the demands increase, optimal quantities of water being necessary to be applied. The water deficit from this period reduces the intensity of chlorophyll assimilation and as a consequence the buds differentiation is reduced (Milică et al., 1982).
In 2016, during May-June when the intense growth of the shoots takes place and the first half of July when the terminal bud forms, it was recorded a rainfall quantity of 197.8 mm compared to

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162.6 mm which represents the multiannual average (for this period), the excess being of 35.2 mm (table 1).

Table 1. Climatic characterization of the year 2016

Month	Monthly sum of the atmospheric rainfall (mm)			Air mean temperature (°C)		
	Monthly sum	Multiannual average	Deviation	Monthly sum	Multiannual average	Deviation
January	16.6	29.4	-12.8	-3.1	-3.6	-0.5
February	23.0	28.1	-5.1	4.8	-1.9	6.7
March	25.0	29.2	-4.2	6.4	3.3	3.1
April	52.4	44.8	7.6	13.5	10.1	3.4
May	62.0	52.5	9.5	15.1	16.1	-1.0
June	121.8	75.1	46.7	20.6	19.4	1.2
July	24.0	69.2	-45.2	22.6	21.3	1.3
August	53.4	57.0	-3.6	21.3	20.6	0.7
September	10.2	40.8	-30.6	18.2	16.3	1.9
October	212.0	32.0	180	8.1	10,1	-2.0
November	69.8	36.2	33.6	4.0	4.1	-0.1
December	20.6	30.3	-9.7	0.4	-0.8	1.2
Annual Σ of the rainfall	**690.8**	**524.6**	**+166.2**	-	-	-
Annual average	-	-	-	**11.0**	**9.6**	**1.3**

The studied walnut genotypes displayed differences concerning their behaviour in the given conditions.

The surface of the trunk's cross-section area (TCSA) at the end of the vegetation period in 2016 was between 10.9 cm^2 ('Sibişel' genotype) and 40.4 cm^2 ('Velnița' genotype) (table 2).

Table 2. Data concerning the trees' vigor for the walnut genotypes in VIthyear from plantation

Genotype	Surface of trunk's section (cm^2) in 2016				
	Annual growth of the trunk (cm^2)	Surface of trunk's section (cm^2)	Calculated compared to the variants average		
			%	Difference	Significance
Velnița	7.7	40.4	179.5	**17.9**	+++
Făleşti	4.5	30.2	134.2	**7.7**	+++
Bortko	14.4	28.1	124.8	5.6	+++
Miroslava	4.5	26.7	118.6	4.2	+++
Schinoasa	5.9	25.3	112.4	2.8	++
Codrene	8.5	24.9	110.6	2.4	+
Recea	6.6	24.6	109.63	2.1	+
Danirenko	6.9	23.9	106.2	1.4	ns
X (average)	-	***22.5***	***100***	-	-
Anica	7.9	19.5	86.6	-3.0	00
Jupâneşti	5.3	17.1	76.0	-5.4	000
Germisara	3.8	16.7	74.2	-5.8	000
Geoagiu 65	7.4	15.5	68.8	-7.0	000
Ovidiu	2.2	11.3	50.2	-11.2	000
Sibişel	1.1	10.9	48.4	-11.6	000

*DL 5% =2.0 cm^2; DL 1% = 2.7 cm^2; DL 0.1% = 3.7 cm^2;+++ - very positive significant differences; ++ - distinct positive significant differences; ns - insignificant differences; 0 – negative significant differences; 000 – very negative significant differences.

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The difference from the variants average was insignificant from the statistical point of view in the case of 'Danirenko' genotype. Very positive significant differences were noticed for the 'Velnița', 'Făleşti', 'Bortko' and 'Miroslava' genotypes, distinct positive significant for 'Schinoasa' genotype and positive significant for 'Codrene' and 'Recea' genotypes. The other genotypes are characterized by very significant and distinct negative significant differences (table 2).
The trees' height (H) registered values between 175.4 cm (for the 'Sibişel' cultivar) and 321.4 cm (for the 'Velnița' cultivar) (table 3).
Compared to the variants average, very positive significant differences have been recorded for the 'Velnița' genotype (88.9 cm) and 'Codrene' (48.7 cm) and for the 'Bortko' genotype (25.1 cm) the difference was distinct positive significant. All the other genotypes recorded very significant and negative significant differences (table 3).

Table 3. Data concerning the trees' height for the walnut genotypes in year VI from plantation

Genotype	Trees' height in 2016			
	Trees' height (cm)	Calculated compared to the variants average		
		%	Difference (cm)	Significance*
Velnița	321.4	138.2	88.9	+++
Codrene	281.2	120.9	48.7	+++
Bortko	257.6	110.8	25.1	++
Recea	246.4	105.9	13.9	ns
Miroslava	243.0	104.5	10.5	ns
X (average)	***232.5***	***100***	-	-
Anica	228.7	98.4	-3.8	ns
Făleşti	228.0	98.1	-4.5	ns
Danirenko	222.8	95.8	-9.7	ns
Schinoasa	222.5	97.7	-10.0	ns
Ovidiu	220.0	94.6	-12.5	ns
Geoagiu 65	213.6	91.9	-18.9	0
Germisara	201.8	86.8	-30.7	000
Jupâneşti	193.4	83.2	-39.1	000
Sibişel	175.4	75.4	-57.1	000

*DL 5% =16.2 cm; DL 1% = 21.9 cm; DL 0.1% = 29.2 cm;+++ - very positive significant differences; ++ - distinct positive significant differences; ns – insignificant differences; 0 – negative significant differences; 000 – very negative significant differences.

Following the observations and determinations done in 2016, the largest values of the annual growth in terms of branches length were recorded for 'Miroslava' (106 cm) and 'Velnița' (94 cm) genotypes, the difference from the variants average being very significant and distinct positive significant compared to the variants average (73 cm). The 'Sibişel' cultivar (50 cm) recorded values inferior to the variants average (table 4) with distinct negative significant differences compared to the variants average. For 'Danirenko' , 'Bortko' and 'Codrene' genotypes, the annual branches length recorded values with insignificant positive values compared to the variants average and for 'Ovidiu', 'Schinoasa', 'Recea', 'Anica', 'Făleşti', 'Geoagiu 65', 'Germisara' and 'Jupâneşti' cultivars the annual shoots length recorded values with insignificant negative differences compared to the variants average (table 4). In May 2015, when the vegetative buds formed, the rainfall deficit was 40.1 mm, provoking reduction of the intensity of chlorophyll assimilation and in consequence the buds differentiation was reduced.

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Table 4. Data concerning the length of the annual branches for the walnut genotypes in VIthyear from plantation

Genotype	The length of annual branches (cm) (average 2016)			
	Branch length (cm)	Calculated compared to the variants average		
		%	Difference	Significance
Miroslava	106	145.2	33	+++
Velnița	94	128.8	21	++
Danirenko	83	113.7	10	ns
Bortko	80	109.6	7	ns
Codrene	79	108.2	6	ns
X (average)	***73***	***100***	-	-
Ovidiu	71	97.3	-2	ns
Schinoasa	71	97.3	-2	ns
Recea	71	97.3	-2	ns
Anica	70	95.9	-3	ns
Făleşti	66	90.4	-7	ns
Geoagiu 65	63	86.3	-10	ns
Germisara	62	84.9	-11	ns
Jupâneşti	59	80.8	-14	ns
Sibişel	50	68.5	-23	00

* DL 5% =14.2 cm; DL 1% = 19.2 cm; DL 0.1% = 25.6 cm;+++ - very positive significant differences; ++ - distinct positive significant differences; ns – insignificant differences; 0 – negative significant differences; 000 – very negative significant differences.

Thus, in 2016 the average number of annual shoots per tree was between 9 (‘Jupâneşti’ genotype) and 71 (‘Ovidiu’ genotype) (table 5).

Table 5. Data concerning the number of annual shoots per tree for the walnut genotypes in VIthyear from plantation

Genotype	Annual shoots in 2016			
	The number of annual shoots (branches/tree)	Calculated compared to the variants average		
		%	Difference	Significance
Ovidiu	71	355	51	+++
Bortko	22	110	2	ns
Velnița	20	100	0	ns
X (average)	***20***	***100***	-	-
Făleşti	19	95	-1	ns
Codrene	19	95	-1	ns
Geoagiu 65	19	95	-1	ns
Miroslava	17	85	-3	ns
Schinoasa	17	85	-3	ns
Recea	17	85	-3	ns
Germisara	17	85	-3	ns
Danirenko	14	70	-6	ns
Anica	11	55	-9	0
Sibişel	11	55	-9	0
Jupâneşti	9	45	-11	00

* DL 5% = 8 items; DL 1% = 11 items; DL 0,1% = 15 items;+++ - very positive significant differences; ++ - distinct positive significant differences; ns - insignificant differences; 0 – negative significant differences; 000 – very negative significant differences.

Very positive significant differences were noticed for the ‘Ovidiu’ cultivar (71 branches/tree), distinct negative significant for the ‘Jupâneşti’ cultivar (9 branches/tree) and negative significant for

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the 'Anica' and 'Sibişel' genotypes (11 branches/tree). For the other genotypes the differences were statistically insignificant in comparison with the variants average (table 5).
By correlating the surface of the trunk's section (TCSA) with the annual shoots length, it was noticed that there is a positive linear correlation with a correlation coefficient r = 0.6817 ($P_{5\%}$= 0.53) that is distinct significant between the parameters (figure 1).

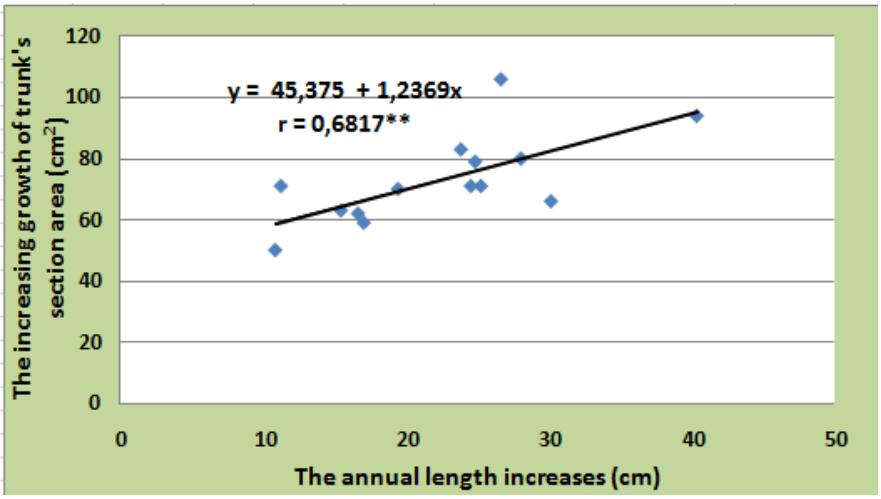

Figure 1. Correlation between trunk cross-sectional area and 1-year shoots length

The correlation between the surface of the trunk's section (TCSA) and the number of annual branches/tree is non-significant with a correlation coefficient r = 0.2492 ($P_{5\%}$= 0.53) (figure 2).
To verify these results, the research requires to be continued in the future for more repetitions.

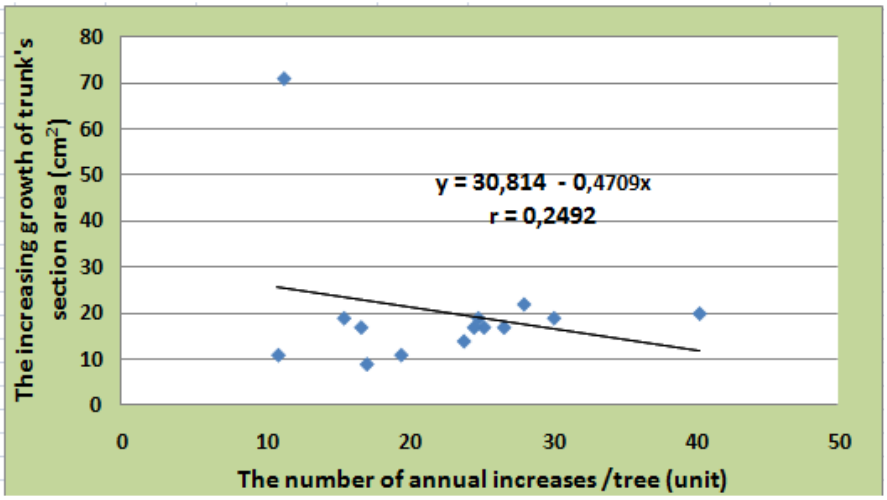

Figure 2. Correlation between trunk cross-sectional area (TCSA) and number of 1-year shoots/tree

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4. CONCLUSIONS

The walnut genotypes studied in the conditions of the N-E area of Romania produced a progressive development of the vegetative organs.

In the conditions of the year taken into study, there got remarked through a weaker vigor the 'Sibişel', 'Ovidiu', 'Geoagiu 65', 'Germisara', 'Jupâneşti' and 'Anica' genotypes, the results being very negative significant compared to the variants average and the 'Ovidiu' cultivar got remarked by the largest number of annual branches/tree.

Concerning the length of the annual shoots, the 'Miroslava' and 'Velnița' genotypes got remarked with values between 94 cm and 106 cm.

In the conditions of the year 2016, the correlation between the growth of the surface of the trunk's section and the length of the annual branches is positive and the correlation between the growth of the surface of the trunk's section and the number of annual branches/tree is non-significant.

To verify these results, the research concerning the assessment of Romanian and foreign walnut genotypes require to be continued in the future on a longer period of time.

5. ACKNOWLEDGEMENTS

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