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RESEARCH ON RESISTANCE OF SOUR CHERRY CULTIVARS IN DROUGHT CONDITIONS IN THE NORTHEASTERN AREA OF ROMANIA

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Abstract

This paper presents aspects recorded in the area of influence of the Research Station for Fruit Growing Iasi during 2020-2022 on five Hungarian sour cherry cultivars, able to capitalize on the Romanian agroclimatic conditions. Analysing from a water stress point of view, the April-July time interval when the intensive growth of shoots took place, during the studied years there was a deficit of -54.2 mm in 2020, -11.2 mm in 2021 and -113.8 mm in 2022 compared to the multiannual amount for this period. Analysing the trunk section area in terms of the average of the three years of study, the values were between 10.5 cm^2 ('Erdi Ipari') and 24.9 cm^2 ('Erdi Bibor'). The highest values for the crown volume were recorded in the cultivars 'Erdi Kordi' (4.53 m^3/tree) and 'Dukat' (4.15 m^3/tree) and the lowest crown volume was recorded in the cultivars 'Erdi Bibor' (3.78 m^3/tree), 'Erdi Kedves' (3.27 m^3/tree) and 'Erdi Ipari' (2.20 m^3/tree). The density of the tree crown recorded values between 4.45 cm^2/m^3 ('Erdi Ipari') and 9.28 cm^2/m^3 ('Erdi Bibor').

***Key words**: crown volume, deficiency, measurements, precipitation, shoots.*

INTRODUCTION

The role of water as a vegetation factor is decisive in the life of plants, representing the main constituent of plant organisms. Water is the vehicle of nutrients and the main thermal regulator (Budan & Grădinariu, 2000; Asănică & Hoza, 2013).

During the growing season, the water consumption of fruit-growing trees is variable. Thus, the critical phases of the vegetation period when the water consumption is maximum are the growth of shoots, the flowering time and the growth of fruits (Toma & Robu, 2000; Ghena & Branişte, 2003; Toma & Jităreanu, 2007).

In the area of influence of the Research Station for Fruit Growing Iasi, the low rainfall throughout the year causes great damage in the sour cherry orchards. The lack of water determines a reduced vigour of the trees, disorder of the regularity of the fruits production and size of the harvests, the aging and shortening of the growth and development stages of the plants, gum discharges (gummosis) and physiological imbalance with pathogenic aspect (Milică et al.,1982; Vasilev et al., 1982; Sestraş, 2004).

The years 2020-2022 can be characterized as years with special climatic peculiarities that have negatively influenced the annual twigs and fruit production in this area.

In this paper we present some aspects recorded in the area of influence of the Research Station for Fruit Growing Iasi during 2020-2022 on some sour cherry cultivars, able to capitalize on the existing agroclimatic conditions.

MATERIALS AND METHODS

The studies were carried out between 2020 and 2022, having as research material five sour cherry cultivars coming from Hungary ('Erdi Ipari', 'Erdi Kedves', 'Erdi Bibor', 'Erdi Kordi', and 'Dukat'), which are in the sixth year after planting. The trees are grafted on *Prunus mahaleb* L., guided as freely flattened palmette. The plantation is placed randomly, in three repetitions of two trees per repetition, at 3.5 x 4 m resulting 714 trees per ha. On the row with trees, the soil was prepared with the rotary orchard tiller and between the rows the soil was grassed.

The land on which the plantation was established was in the Jijia-Bahlui depression, where the multiannual average temperature was 10.2°C.

The meteorological factors (during the three years of study) were analysed along with the behaviour of the cultivars towards the drought that took place during the studied period and biometric measurements and determinations of the tree and of the shoots were performed (the trunk section area (TSA), the height of the tree (H), the volume of the crown (CV), the length of the annual twigs (LCA) and their amount on the tree, the density of the crown (CD).

The height of the tree (H) and the length of the annual twigs (LCA) were measured with the measuring roulette, the trunk section area (TSA) was measured by using the calliper on the thickness of the trunk in two perpendicular directions 30 cm high from the grafting point (and the data taken at TSA were transformed into cm^2). In order to calculate the average volume (m^3) of the crown of the trees, the Sarger method was used with the formula: $\mathbf{V = (D + d/2)^2 \times H \times 0.416}$, in which: CV - the volume of the crown, D – the diameter of the crown in the direction of the row of trees, d - the average diameter of the thickness of the fruiting hedge, H - the height of the trees, 0.416 - the correction coefficient (Lamureanu et al., 2013), the density of the crown was calculated according to the formula: **TSA (cm^2)/ CV (m^3)** (Parnia & Mladin, 1995).

The experimental data were interpreted statistically by the variance analysis and the method of multiple comparisons (Duncan test, with P 5%). The determination of the correlation coefficient (r) was performed using Bravais's formula (Timariu et al., 1978).

RESULTS AND DISCUSSIONS

In sour cherry, the requirements for water increase starting with April and they rich the highest point in the months of May-July, when the intensive growth of the shoots takes place (Roversi & Ughini, 1993), then in August when the growth of the shoots ceases (the synthesis of carbohydrate substances, proteins, etc. takes place), followed by their thickening and at the same time the differentiation of the buds begins (Teaci et al., 1982; Grădinariu & Istrate, 2003).

The average annual temperatures recorded had the following values: 12.1°C in 2020, 10.1°C in 2021, and 11.3°C in the first seven months of 2022 (the multiannual average being 10.2°C).

Analysing the same period for the rainfall parameter, the years 2020 (448.4 mm) and 2022 (142.4 mm the first seven months of the year) recorded quantities below the multiannual limit (562.6 mm), achieving a deficit of 114.2 mm in 2020 and 266.5 mm during January-July 2022. More, in 2021, the quantity of rainfall was close to the multiannual average (Table 1).

From the analysis of the trunk section area (TSA) in the sixth year (2022) after planting it was found that the largest TSA was recorded in the 'Erdi Bibor' cultivar (35.1 cm^2), and the smallest in 'Erdi Ipari' (9.8 cm^2).

Analysing this parameter in terms of the average of the three years of study, it can be noticed that they do not have statistically insured values, thus, negative differences in comparison with the average of the variants (19.4 cm^2) were recorded by the cultivars 'Erdi Ipari' (10.5 cm^2), 'Erdi Kedves' (19.1 cm^2) and 'Dukat' (19.3 cm^2), and the cultivars 'Erdi Bibor' (24.9 cm^2), and 'Erdi Kordi' (23.0 cm^2) recorded positive differences in comparison with the average of the variants (19.4 cm^2) (Table 2).

Correlating these parameters for the trees in their 6^{th} year since planting resulted in a positive correlation coefficient (R^2= 0.7049), statistically non-significant (Figure 1). Low vigour of the tree is an important parameter for establish high density of the orchards, the new trends in the fruit tree growing being to increase constant the productivity (Stănică, 2019). From our results, the cultivars 'Erdi Ipari', 'Erdi Kedves', and 'Dukat' are suitable for higher densities per hectare.

Analysing the crown volume (CV), the highest values were recorded in the cultivars 'Erdi Kordi' (4.53 m^3/ tree, 3234.4 m^3/ha) and 'Dukat' (4.15 m^3/tree, 2963.1 m^3/ha), and the lowest volume of the crown was recorded by the cultivars 'Erdi Ipari' (2.20 m^3/tree, 1570.8 m^3/ha), 'Erdi Kedves' (3.27 m^3/tree, 2334.7 m^3/ha), and 'Erdi Bibor' (3.78 m^3/tree, 2698.9 m^3/ha) (Table 2). According to Kiprijanovski et al. (2018), crown sizes depend on lots of factors, like rootstock vigorousness, planting distance, or the correction by pruning.

The density of the tree crown (CD) had values between 4.45 cm^2/m^3 ('Erdi Ipari') and 9.28 cm^2/m^3 ('Erdi Bibor') (Table 2).

Table 1. Climatic characterization of the years 2020-2021-2022

Year/Month			January	February	March	April	May	June	July	August	September	October	November	December	Annual sum (mm)	Annual average (ºC)
Monthly sum of the precipitations (mm)	Multiannual average		**35.5**	**32.1**	**71.2**	**51.4**	**71.1**	**82.9**	**64.7**	**50.8**	**36.5**	**2.4**	**33.4**	**30.6**	**562.6**	x
	2020	Monthly sum	3.6	40.4	17.4	0.8	67.8	82.6	32.8	13.4	30.2	85.2	17.8	56.4	448.4	x
		Deviation	-31.9	+8.3	-53.8	-50.6	-3.3	-0.3	-31.9	-37.4	-6.3	+82.8	-15.6	+26.2	**-114.2**	x
	2021	Monthly sum	24.0	23.6	52.2	46.6	70.4	99.6	55.4	127.2	11.6	4.4	9.6	39.0	563.6	x
		Deviation	-11.5	-8.5	-19.0	-4.8	-0.7	+16.7	-9.3	+76.4	-24.9	+2.0	-23.8	-8.4	**+1.0**	x
	2022*	Monthly sum	6.6	10.4	6.0	58.0	17.4	16.2	27.8	-	-	-	-	-	142.4	x
		Deviation	-28.9	-21.7	-65.2	+6.6	-53.7	-66.7	-36.9	-	-	-	-	-	**-266.5**	x
Average air temperature (ºC)	Multiannual average		**-1.9**	**-1.2**	**4.7**	**11.4**	**17.0**	**20.5**	**22.4**	**21.9**	**16.3**	**5.4**	**5.4**	**0.1**	**x**	**10.2**
	2020	Monthly average	0.9	4.2	7.6	11.5	14.0	20.9	22.6	23.6	19.6	13.9	4.5	2.0	x	+12.1
		Deviation	-1.0	-3.0	+2.9	+0.1	-3.0	+0.4	+0.2	+1.2	+3.3	+8.5	-0.9	+1.9	x	**+1.9**
	2021	Monthly average	0.1	-0.6	3.4	8.2	15.1	19.6	23.2	20.9	14.9	9.4	6.5	0.6	x	+10.1
		Deviation	-1.8	-0.6	-0.3	-3.2	-1.9	-0.9	+0.8	-1.0	-1.4	+4.0	+1.1	+0.5	x	-0.1
	2022*	Monthly average	0.4	3.7	3.2	10.0	16.6	21.9	23.2	-	-	-	-	-	**x**	+11.3
		Deviation	-1.5	+2.5	-1.5	-1.4	-0.4	+1.4	+0,8	-	-	-	-	-	**x**	**+1.1**

*In 2022, the data for the first seven months of the year (January-July) was displayed

Table 2. Tree growth vigour and crown volume for some sour cherry cultivars in the sixth year after planting (RSFG Iasi; average of 2020-2022)

Cultivar	Trunk section area (cm^2)		Crown volume in the 6^{th} year (m^3)		Crown density cm^2/m^3
	Year VI*	Average of the years IV-VI	per tree	per ha	
Erdi Bibor	35.1^{a}	24.9	3.78^{b}	2698.9	9.28^{a}
Erdi Kordi	30.8^{ab}	23.0	4.53^{a}	3234.4	6.80^{b}
Dukat	28.3^{b}	19.3	4.15^{ab}	2963.1	6.82^{b}
Erdi Kedves	27.9^{b}	19.1	3.27^{b}	2334.7	8.53^{ab}
Erdi Ipari	9.8^{c}	10.5	2.20^{bc}	1570.8	4.45^{bc}
Average (x)	***26.4***	***19.4***	***3.59***	***2560.3***	***7.18***
DL 5% DL 1% DL 0.1%	DL 5% = 1.74	6.4 9.2 13.9	DL 5% = 0.22		DL 5% = 0.05

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

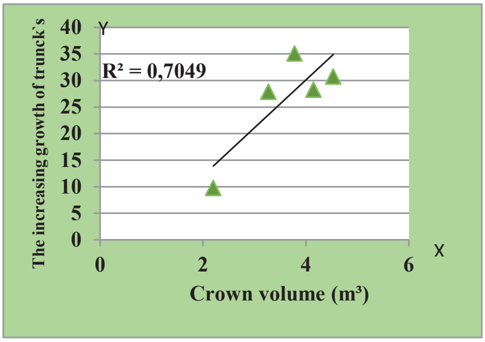

Figure 1. Correlation between trunk section area (cm^2) and crown volume (m^3)

In August, when the growth of the shoots ceased (the apical bud is outlined at the top of the shoots), the length of the annual twigs in the studied sour cherry cultivars were counted and measured.

Analysing from a water stress point of view, the April-July time interval when the intensive growth of shoots takes place, in the studied years there was a deficit of -54.2 mm in 2020, of -11.2 mm in 2021, and of -113.8 mm in 2022 in comparison to 270.1 mm representing the multiannual amount for this period (Table 1).

It is known that the lack of water reduces the number and growth in length of annual shoots, the photosynthesis, the transport of substances in the plant and decreases the turgidity of cells (Toma & Jităreanu, 2007). According with that we recorded the number of annual twigs per tree in conditions of the average of the three years of study (2020-2022) and we observe that the cultivars 'Erdi Bibor' with 58 twigs/tree, 'Erdi Kordi' with 49 twigs/tree and 'Erdi Kedves' with 45 twigs/tree got highlighted with the highest amount of twigs per tree, recording positive differences in comparison with the average of the cultivars (43 pcs.). But, the cultivars 'Dukat' with 26 twigs/tree and 'Erdi Ipari' with 36 twigs/tree got highlighted as the cultivars with the smallest amount of twigs per tree, recording negative differences in comparison with the average of the cultivars (Table 3). Mika et al., 2011, showed that the presence of the annual and two-year-old shoots are favourable to the abundant setting of flower buds and to flowering so after pruning should remain only these younger branches for a good production.

Correlating the mean of the IV-VI years of the trunk section area (cm^2) with the mean of the IV-VI years of the amount of annual twigs on tree (pcs), it was noticed that the two parameters are positively correlated (R^2 = 0.3797), however statistically non-significant (Figure 2).

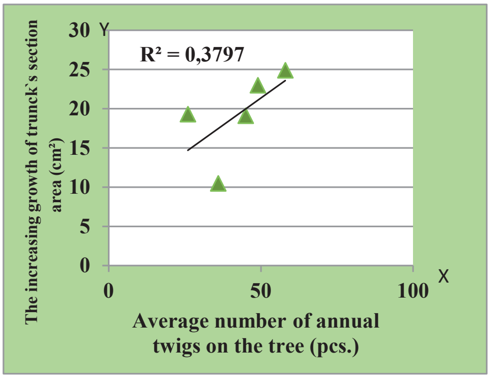

Figure 2. Correlation between trunk section area (cm^2) and the amount of annual twigs/tree (pcs.)

Analysing the average length of the annual twigs in the studied three years, this parameter oscillated between 45.7 cm ('Erdi Ipari') and 69.6 cm ('Dukat'), statistically, the 'Dukat' cultivar recording positive differences in comparison with the average of the cultivars (56.2 cm) (Table 3). Correlating the mean of the IV-VI years for the trunk section area (cm^2) with the mean of the IV-VI years for the annual twigs length (cm), it was noticed there was a positive correlation between the two parameters (R2 = 0.2076), statistically non-significant (Figure 3). Considering that during May-July when the growth and development of the tree shoots takes place, the rainfall was reduced (in comparison with the multiannual average for this period (218.7 mm), the deficit was -35.5 mm in 2020, -6.7 mm in 2021, and -157.3 mm in 2022), the entire physiological activity of the tree was reduced, recording reduced values for the studied vegetative pomological parameters.

Table 3. Data on the number of annual twigs per tree and their average length for some sour cherry cultivars in the sixth year after planting (RSFG Iasi; average of 2020-2022)

Cultivar	Average number of annual twigs on the tree (pcs.)				The average length of annual twigs (cm)			
	Year IV	Year V	Year VI	Average of the years IV-VI*	Year IV	Year V	Year VI	Average of the years IV-VI
Erdi Bibor	38^{++}	52	84	58^{a}	45.3	84.2	43.4	55.6^{ab}
Erdi Kordi	17	52	78	49^{ab}	25.0	91.3	49.2	55.4^{b}
Erdi Kedves	18	37	81	45^{b}	21.2	92.7	53.5	54.5^{b}
Erdi Ipari	14	36	59	36^{bc}	20.7	75.0^{000}	44.8	45.7^{b}
Dukat	15	28	36	26^{c}	37.7	120.0^{++}	62.7	69.6^{a}
Average (x)	***20***	***41***	***67***	***43***	***30.0***	***92.6***	***50.7***	***56.2***
DL 5% DL 1% DL 0.1%	11.7 17.0 25.5	16.1 23.4 35.2	49.7 72.4 108.6	DL 5% = 5.44	22.6 32.9 49.4	17.6 25.7 38.5	18.1 26.4 39.6	DL 5% = 5.96

*- different letters correspond with the significant statistical difference for P ≤ 5%, Duncan test.

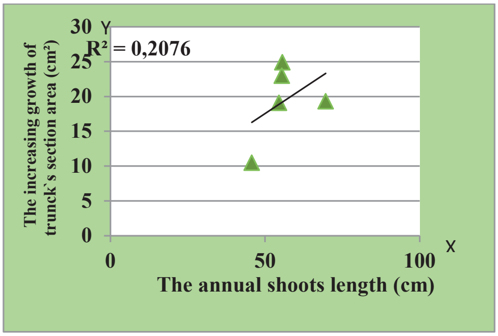

Figure 3. Correlation between trunk section area (cm^2) and annual shoots length (cm)

According to rainfall amount in the studied period (Table 1) we observed that 'Erdi Bibor' recorded an higher number of annual twigs (Table 3) on the tree in conditions of 2021 and 2020, while 'Dukat' recorded an higher length of annual twigs in conditions of 2021.

CONCLUSIONS

The research carried out in a period characterised by great climatic fluctuations, prove that the studied sour cherry cultivars have a good resistance to the agroclimatic conditions recorded during the studied period in the North-East area of Romania.

Analysing the values recorded for all the determined parameters, it was found that the five sour cherry cultivars in the sixth year after planting, have different biological traits of growth.

Regarding the volume of the crown of the trees, it was estimated that the smallest crowns were presented in the cultivars 'Erdi Ipari', 'Erdi Kedves', and 'Erdi Bibor' which had a tight growth of the crown.

Under the conditions of dry years, the cultivars highlighted as the most resistant to drought (with a large number of annual twigs on the tree and high values for their length) were 'Erdi Bibor', 'Erdi Kordi', and 'Erdi Kedves'.

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