Scientific Papers. Series B, Horticulture. Vol. LXVII, No. 1, 2023
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

STUDY OF THE WATER REGIME IN SOME SWEET CHERRY CULTIVARS UNDER NORTH-EASTERN ROMANIAN CONDITIONS

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Abstract

The soil and climate conditions in the North-East area of Romania are considered suitable for sweet cherry cultivation, but sometimes problems may arise due to the intensification of global climate changes, mainly in terms of the water component. This study was conducted during the year 2022 using three sweet cherry tree cultivars as biological material: ‘Van’, ‘Andreiaș’ and ‘Margonia’ from Research Station for Fruit Growing (RSFG) Iași. The aim of this research was to evaluate physiological aspects of the water regime of the sweet cherry tree by determining the rate of dehydration, water content as well as the stomatal conductance of the leaves from different levels of the trees. Physiological determinations were carried out in three different phenological stages according to Biologische Bundesanstalt, Bundessortenamt and CHemical Industry (BBCH) scale: full flowering (BBCH 65), fruit growth (BBCH 75), and fruit ripening (BBCH 89) and were correlated with the registered climate data.

***Key words**: dehydration rate, Prunus avium* L.*, stomatal conductance, water content.*

INTRODUCTION

Sweet cherry (*Prunus avium* L.) is an important fruit tree species in Romania and occupies an area of 6,120 ha and an average production of 74,930 t/year (FAO, 2021) with a large expansion in the following years through new established plantations.

Production and survival of fruit trees in temperate zones depend on phenophases and time of growth in synchrony with temperature seasonal changes. Recent research shows that global climatic changes have influenced plants especially in the development of phenological stages (Ansari and Davarynejad, 2008; Balaci et al., 2008; Sîrbu et al., 2016). Many results showed that climate change influence greatly the plant’s growth and its development. Meteorological factors restrict the biological cycle as well as the plant’s productive potential (Slabu et al., 2012).

Water and temperature stresses are the main limiting factors in crop production worldwide (Shah et al., 2011; Ozherelieva & Lyakhova, 2021). Low water availability and abnormally high temperatures cause changes in plant metabolism and lead to water exchange violation in plants, at early phenological stages, transpiration and photosynthesis are affected, efficiency of water use increases, while senescence and fruit falling are stimulated (Jităreanu et al., 2009). Influenced by drought, plants experience cell dehydration and suffer from a considerable increase in the temperature of their tissues; all having a direct impact on photosynthesis (Toma et al., 2008) and an indirect impact on the entire metabolism. By changing the metabolism, the lack of water affects productivity, taste of fruits, and wood density (Ozherelieva & Lyakhova, 2021).

In plant species diversity, sweet cherry is a tree species whose leaves with a larger open stomatal pore area have a higher stomatal conductance and typically higher rates of photosynthetic CO_2 assimilation and water loss through transpiration (Franks & Farquhar, 2007). However, plants must maintain their hydration within narrow limits, and the high transpiration rate causes the water potential to decrease throughout the plant, which would cause mesophyll damage and xylem embolism during drought. Plants thus close their stomata in response to the drop in leaf water potential (McElwain, 2016; Henry et al., 2019).

The objective of this study was to evaluate the behaviour of some sweet cherry cultivars based on their phenological stages progress and on the dynamics of the water regime in terms of climatic conditions of the year 2022 in the North-East (N-E) area of Romania.

MATERIALS AND METHODS

The experiments were performed during 2022 on three sweet cherry cultivars existing in the germplasm fund from Research Station for Fruit Growing (RSFG) Iaşi - Romania. The studied sweet cherry cultivars: 'Van', 'Andreiaș' and 'Margonia' were cultivated on *P. mahaleb* L. seedlings rootstock.

The foliar dehydration rate was performed at 1, 2, 3, 4 and 24 hours intervals, determining the total content of bound water, referring to the percentage of water lost in the first hour and in 24 hours, depending also on the free water content of the samples. Water content of plant leaves was calculated by the formula:

$DR = \frac{x_{1-n}}{x_0} \times 100\%$, where: DR - foliar dehydration, %; x_0 - the first weighing of the leaf, g; x_{1-n} - leaf weight after certain periods of time (one to 24 hours), g (Jităreanu & Marta, 2020).

Dry matter content in leaves was determined, using the formula (Cupcea et al., 1965, cited by Popoviciu, 2018):

$DM = \frac{m_f}{m_i} \times 100\%$, where: DM - Dry matter content, %; m_i - weight of fresh material, g and m_f - weight of oven-dried material, g.

Stomatal conductance (g_s) measurements were carried out simultaneously with leaf water potential measurements, on the same trees by a leaf porometer. Leaf samples were taken from the sunexposed mature leaves of one year old shoots from different sides of the selected plants (Küçükyumuk et al., 2015).

Physiological determinations were performed on different phenological stages, according to Biologische Bundesanstalt, Bundessortenamt and Chemical Industry (BBCH) scale and Meier et al. (1994) at: full flowering (BBCH 65), fruit growth (BBCH 75) and fruit ripening (BBCH 89). The obtained results have been interpreted in relation with climatic conditions. The climatic data were recorded with the AgroExpert system of the RSFG Iaşi, Romania. Some obtained results were statistically analysed and the differences were determined by Duncan's test ($p \leq 0.05$).

RESULTS AND DISCUSSIONS

The evolution of climatic factors under the conditions of the year 2022, in the Iași area (North-Eastern of Romania) was analyzed every month and presented in Table 1.

Table 1. Climate condition at Iaşi county during the experimental period (RSFG Iași-Romania, 2022)

Month	Average annual temperature (°C)			Total annual precipitation (mm)		
	Monthly av.	Multiannual	Deviation	Monthly sum	Multiannual	Deviation
I	0.40	-3.30	-3.70	6.60	34.40	27.80
II	3.66	-1.50	-5.16	10.40	34.60	24.20
III	3.23	3.10	-0.13	56.94	28.90	-28.04
IV	10.02	10.30	0.28	58.00	28.90	-29.10
V	16.62	16.10	-0.52	17.40	27.40	10.00
VI	21.90	19.40	-2.50	26.60	28.10	1.50
VII	23.20	21.30	-1.90	27.80	40.30	12.50
VIII	22.50	20.50	-2.00	69.00	52.50	-16.50
IX	15.50	16.30	0.80	69.60	75.10	5.50
X	12.30	10.10	-2.20	12.60	69.20	56.60
XI	5.50	4.00	-1.50	69.20	57.60	-11.60
XII	1.40	-0.90	-2.30	16.20	40.80	24.60
Average/sum	**11.35**	**10.64**	**-0.71**	**440.34**	**517.80**	**77.46**

The monthly average of air temperature and the total amount of precipitation being established, as well as the deviation from the multiannual average. Thus, it was registered an annual average of 11.35°C, with a deviation from thermal multiannual average of 0.71°C.

The amount of precipitation recorded during analyzed period had values of 440.34 mm and was characterized by a deficit of 77.46 mm.

The months of interest for the pursuit of the studied phenophases were March, April, May, and June when the temperature was higher by +2.87°C than the multiannual average and precipitation deviation was higher with 45.64 mm although as annual average it was pedological drought. The absence of rain and the high diurnal and nocturnal temperatures lead to the appearance of pedological, atmospheric and physiological drought, thus shortening the phenophases (Jităreanu et al., 2009).

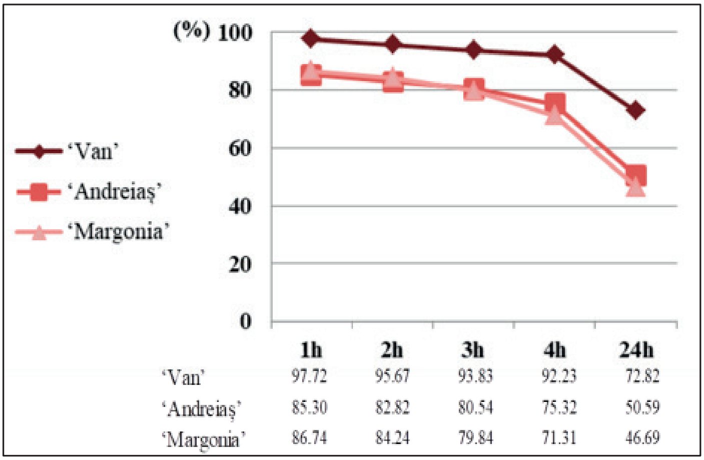

Figure 1. Evolution of dehydration rhythm in full flowering phenophase (65 BBCH sweet cherry cultivars, RSFG Iași, Romania, 2022)

The foliar dehydration rhythm was analyzed and graphically represented as follows: full flowering - 65 BBCH (Figure 1), fruit growth - 75 BBCH (Figure 2) and fruit ripening - 89 BBCH (Figure 3). In the flowering phenological stage, the dehydration rhythm drops from 97.72% ('Van'), 85.30% ('Andreiaş') and 86.74% ('Margonia') to 72.82%, 50.59% respectively, 46.69%, after 24 h. The most intense foliar rhythm of dehydration was recorded in the phenophase of fruit growth, recording differences of approximately 45% during 24 hours ('Van') (Figure 2). There are no evident differences between the studied cultivars.

During fruit ripening phenophase, the foliar dehydration rhythm was more intense at 'Andreiaş' cultivar, registering values of 31.67%.

The average values of the sweet cherry cultivars studied recorded minimum values of the dehydration rate, in the phenophase of fruit ripening, of 27.56% and maximum in the phenophase of fruit growth, of 39.24%.

These results are in a close relation with temperatures, normal for the period and with an excess of precipitation.

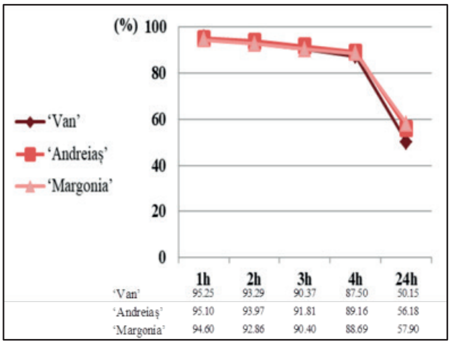

Figure 2. Evolution of dehydration rhythm in fruit growth phenophase (75 BBCH sweet cherry cultivars, RSFG Iași, Romania, 2022)

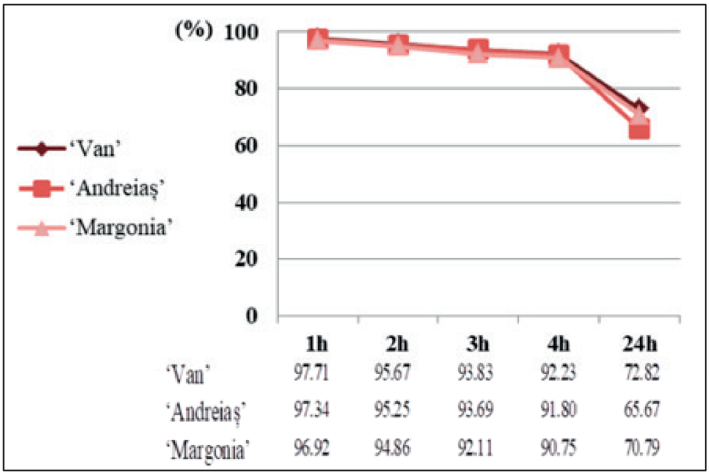

Figure 3. Evolution of dehydration rhythm in fruit ripening phenphase
(89 BBCH sweet cherry cultivars, RSFG Iași, Romania, 2022)

Averages of stomatal conductance measurements made in different phenological stages are shown graphically in Figure 4. The stomatal transpiration rate decreased during the fruit growth phenophase. Stomatal conductance recorded the highest values in the fruit ripening phenophase, between 14.73 ('Van') and 16.81 mol $H_2O/m^2/s$ ('Margonia').

The lowest stomatal conductance values were recorded in the phenophase of fruit growth, when all physiological processes are intensified and were between 7.01 ('Van') and 7.57 mol $H_2O/m^2/s$ ('Margonia').

The partial closure of stomata increases the availability of water in the plant and decreases dehydration stress in drought conditions (Henry et al., 2019). The varied stomatal conductance is a response of the trees to the water supply relative to the needs of the plant and the phenological stage (Downton et al., 1990).

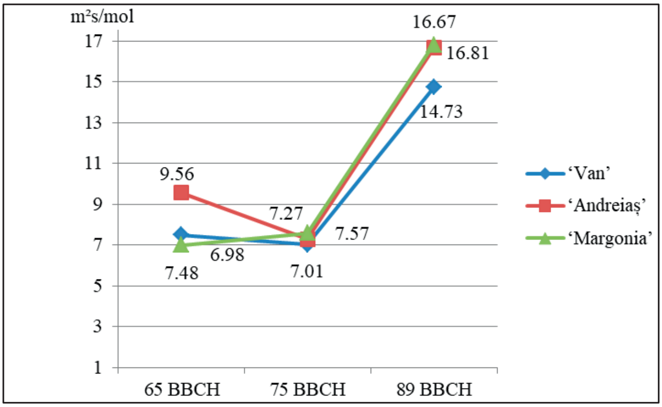

Figure 4. Stomatal conductance in different phenological stages
at sweet cherry cultivars (RSFG Iași, Romania, 2022)

The dry matter content of the leaves of the sweet cherry cultivars studied in three different phenological stages is presented in Table 2. The dry matter content values varied both between cultivars and phenophases. Thus, the highest dry substance content of the leaves was recorded in the phenophase of fruit ripening (36.22% at 'Van' cultivar, 37.91% 'Andreiaș' cultivar and 35.52% 'Margonia' cultivar). Statistically significant differences were highlighted between the flowering and fruit ripening phenophases. On average, the lowest amount of dry matter in the leaves was at 'Van' cultivar (29.09%) in flowering phenological stage. The maximum accumulation of dry matter in sweet cherry leaf tissues (36.55%) due the natural aging of the leaves was also accompanied by a decrease in water content, which is primarily due to environmental conditions.

Table 2. Dynamic of dry matter (%) content in the leaves in different phenophases at sweet cherry cultivars (RSFG Iași, Romania, 2022)

Phenophase[1]	**'Van'[2]**	**'Andreiaș'**	**'Margonia'**
65 BBCH	29.09[b]	33.40[b]	29.66[b]
75 BBCH	35.88[a]	30.81[b]	35.25[a]
89 BBCH	36.22[a]	37.91[a]	35.52[a]
Min.	**29.09**	**30.81**	**29.66**
Max.	**36.23**	**37.91**	**35.52**
Average	**33.74**	**34.05**	**33.48**

1-BBCH-Phenological growth stages (Meier et al., 1994): 65 (full fowering); 75 (fruit growth); 89 (fruit ripening);
2-Different letters after the number correspond with statistically significant differences for *p* 5% - Duncan test.

Other authors note an average of dry matter accumulation over the years, in drought summer conditions of 38.6%, 2.8% higher than in conditions of sufficient water availability, in the case of cherry (Ozherelieva & Lyakhova, 2021) and plum trees (Prudnikov, 2022).
The dry matter content is taken as a parameter associated with the optimal water regime and which characterizes the metabolic processes. The accumulation of dry matter by plants is the result of the relation with environmental factors and allow the assessment of growth and development conditions.

CONCLUSIONS

The climatic conditions analysed during the year 2022 had a favorable evolution in terms of temperature and the amount of precipitation for growth and development of the studied sweet cherry cultivars.
The most intense foliar dehydration rate was recorded in the phenophase of fruit growth and development, when in terms of total rainfall, a surplus was recorded.
The dry matter content of sweet cherry leaves varied according to climatic factors and the phenophase, being lower during periods with lower temperatures and abundant precipitation and higher when temperatures are higher and the precipitation quantitatively lower.
The optimal values regarding the sweet cherry studied cultivars water regime indicators have been in accordance with the phenological stage and climatic conditions.
The results of this study could help to improve the cultivation of sweet cherry, as well as other *Prunus* fruit trees with similar phenology and water stress behavior, not only in areas where water is insufficient, but also in regions where water availability is not a problem at the present, even without additional irrigation.

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