Fruit Growing Research, Vol. XXXIX, 2023 DOI 10.33045/fgr.v39.2023.07
https://publications.icdp.ro/index.php

# DINAMICA PROCESULUI DE FOTOSINTEZĂ LA UNELE SOIURI DE CIREȘ ÎN CONDIȚIILE CLIMATICE DE LA SCDP IAȘI
# THE DYNAMICS OF THE PHOTOSYNTHESIS PROCESS IN SOME SWEET CHERRY CULTIVARS UNDER THE CLIMATE CONDITIONS AT RSFG IASI

Mineață Iulia[1], Golache Iuliana Elena[1*], Sîrbu Sorina[1], Iurea Elena[1], Perju Ionel[1], Ungureanu Ionut[1], Jităreanu Carmen Doina[2]
[1]Research Station for Fruit Growing Iași, Romania,
[2]University of Life Sciences Iași, Romania
*Corresponding author: Golache Iuliana; e-mail: golacheiuliana@yahoo.com

**Abstract**

**The purpose of this study was to evaluate the influence of climatic conditions in the photosynthesis process at three cultivars of sweet cherry ('Van', 'Andreiaș' and 'Margonia') from the Research Station for Fruit Growing (RSFG) Iași. The ecophysiological response of the sweet cherry tree species was determined by evaluating the influence of light intensity on photosynthesis, as well as by determining the content of photosynthetic and carotenoid pigments of the leaves in different phenological stages (66 BBCH, 75 BBCH and 89 BBCH). The content of pigments in the leaves was analyzed spectrophotometrically, being estimated by the value of the light absorption capacity of the acetonic extract of pigments (1%) in the visible spectrum at different wavelengths. The obtained results showed that the intensity of the photosynthesis process has maximum values in the fruit ripening phenophase, the content in photosynthetic pigments (chlorophyll *a* and *b*) registering maximum values of 14.28 µg/mL, at an average light intensity of 53,000 lux.**

**Cuvinte cheie: *Prunus avium* L., intensitatea luminii, pigmenți, frunze, fenofaze**
**Key words: *Prunus avium* L., light intensity, pigments, leaves, phenophases**

## 1. Introduction

The sweet cherry (*Prunus avium* L.), is one of the most valued and important fruit species in the temperate zone, occupying in Romania an area of 6,000 ha and an average production of 75,000 t/year (FAO, 2021) with a large expansion in the following years through newly established plantations.

Physiologically, sweet cherry trees have the highest photosynthetic intensity of all stone crops (Flore and Layne, 1999). Distinct biochemical and morphological changes occur during each growth stage, but fruit ripening, including colour intensity and sugar accumulation are directly influenced by climatic conditions (Ren et al., 2010).

Also, light is a fundamental condition during plant development, directly influencing the formation of flower buds from the next year (Corelli Grappadelli et al., 2003; Shtai et al., 2008).

The content of chlorophyll pigments depends on a large number of factors - the light level (Balan, 1978), the scion-rootstock combination (Moreno et al., 2001; Asanică et al., 2015) and agrotechnical conditions (Todaria et al., 1980 ; Viljevac et al., 2013).

This study was carried out with the aim of evaluating the influence of local climatic conditions and light intensity on the activity of the photosynthesis process in some sweet cherry cultivars from RSFG Iași.

## 2. Material and methods

The experiment was carried out during 2022 year on three cultivars of sweet cherry ('Van', 'Andreiaș' and 'Margonia') from RSFG Iași - Romania. The studied sweet cherry cultivars were grafted on *P. mahaleb* L. rootstocks at a distance of 5×4 m, driven in the form of a freely flattened palmette in the direction of the row, without support or irrigation system.

During the study, the climatic conditions in the area (temperature and precipitation) were monitored with the AgroExpert system of RSFG Iaşi, Romania located in the experimental field. The studied area was characterized by a multiannual average temperature of 10.8°C and a total precipitation of 568.7 mm (2010-2020).

Physiological determinations were carried out at different phenological stages, according to the BBCH scale (Meier, 2001) at: full flowering (BBCH 65), fruit growth (BBCH 75) and fruit ripening (BBCH 89).

Light intensity measurements were performed directly in the experimental field with the AccuPAR LP-80 device in the top and middle areas of the crown, compared to the upper area of the tree. At each analyzed phenological stage, the measurements were made at same hours: 9:30, 13:00 and 18:00.

The content of photosynthetic pigments in the leaves was determined by the spectrophotometric method described by Jităreanu (2007). The method allows the testing of pigments with the UV/Vis spectrophotometer at wavelengths 470, 647 and 663 nm. The content of different types of pigments was evaluated based on the light absorption capacity of the acetone extract (1%), based on Lichtenthaler's equations (Lichtenthaler H.K., 1987; Welburn A.R., 1994):

$Ca = 12.25 \times A663 - 2.79 \times A647$

$Cb = 21.50 \times A647 - 5.10 \times A663$

$Ca+b = 7.15 \times A663 - 18.71 \times A647$

$Cx+c = (1000 \times A470 - 1.82 \times Ca - 85.02 \times Cb)/198.$

Some of the experimental data was interpreted statistically using the method of multiple comparisons (Duncan test, with $p \leq 5\%$).

### 3. Results and discussions

The evolution of climatic conditions from the 2022 year, under the conditions of RSFG Iași, was analyzed monthly and took into account the determination of the average and monthly sum of air temperature and precipitation, as well as their deviation from the multiannual average (2010-2020) (Table 1).

The data presented showed that the monthly average air temperature from 2022 registered a progressive increase starting from April to August, followed by a decrease in September. During the vegetation period (March-September), the values exceed the multiannual average temperature of the area with differences between -0.8ºC (September) and +2.5ºC (June). The annual temperature average recorded was 11.35ºC, with an increase of +1.7ºC compared to the multiannual average. The maximum average of monthly temperature was in July, with an average value of 23.2ºC, 35.5ºC being the maximum daily temperature (July 5).

The amount of precipitation during the 2022 year summed up 440 mm, with a deficit of 77 mm. An excess of precipitation was recorded in March, April and August, with negative effects on pollination during the flowering phenophase that took place in April.

The high daytime and nighttime temperatures, as well as the lack of precipitation, led to the installation of pedological, atmospheric and physiological drought, which has effects on the vigour of the trees, the shortening of the development phenophases, the reduced productivity and the reduced quality of the fruits.

The determination of light intensity during the vegetation period (Table 2) showed maximum values of 53,395 lux, in the phenophase of fruit ripening. The light intensity during the evaluated phenological stages varied depending on the cultivar and the temperature recorded at the time of their phenological development. Thus, the maximum values are recorded in the fruit ripening (89 BBCH) phenophase of the 'Van' cultivar (the last decade of May), a period overlapping with the fruit growth phenophase (75 BBCH) of the 'Andreiaș' and 'Margonia' cultivars. The maximum value was 74,555 lux, recorded in the area above the tree of the 'Andreiaş', in the phenophase of fruit growth. The high values of light intensity can be explained by the high temperatures during this period, having a deviation from the multiannual average of 3.02ºC, as well as by the reduced cloudiness, which caused a precipitation deficit of -11.5 mm.

The light intensity evaluated in the three areas of the crown did not show major differences, which was due to the shape of the crown which ensures a uniform distribution of the light of the entire crown. The dynamic evolution of light intensity in different phenophases was graphically represented in Fig. 1.

Spectrophotometric determinations allowed the assessment of the content of green or chlorophyll pigments (C*a* and C*b*) and yellow pigments or carotenoids (carotenes and xanthophylls) with an important role in resistance to stress conditions (Table 3).

The obtained results showed that the highest content of photosynthetic pigments was recorded in the phenophase of fruit ripening, which in sweet cherry overlaps with the moment when the tree directs its metabolic effort towards the process of differentiating the fruit buds for the following year.

Analyzing the dynamics of pigment content outside and inside the crown, a slight increase in chlorophyll pigments was found inside the tree crown, in contrast to carotenoid pigments, which had higher values towards the outside of the crown.

The average content of chlorophyll and carotenoid pigments in different phenological stages was graphically represented for the three varieties evaluated: 'Van' (Fig. 2a), 'Andreiaș' (Fig. 2b) and 'Margonia' (Fig. 2c).

Compared to the other analyzed cultivars, 'Van' recorded the highest values of the content in chlorophyll pigments in the phenophase of full flowering (11.22 µg/mL) increasing progressively up to 14.87 µg/mL, in the phenophase of fruit ripening (Fig. 2a).

At 'Andreiaș' cultivar, the content of photosynthetic pigments evolves in the form of a downward curve, the minimum value being recorded in the phenophase of fruit growth (Fig. 2b).

In the phenophase of fruit ripening, 'Margonia' cultivar obviously differs from the point of view of the average content of leaf pigments, reaching values of up to 16.10 µg/mL in the phenophase of fruit ripening (Fig. 2c).

The biosynthesis of carotenoid pigments in the leaves remains constant during the three analyzed phenophases, showing a slight increase in the fruit ripening phenophase. The maximum value was recorded in the 'Margonia' cultivar (Table 3).

Against the background of a rainfall deficit recorded during the phenophase of fruit growth, it was found that the 'Van' and 'Margonia' recorded a decrease in the content of pigments responsible for resistance to biotic and abiotic stress factors. These slightly lower values than in the previous phenophases indicate a sensitivity of the two cultivars to drought-induced stress conditions, which highlights that in the vegetation period specific to fruit growth, the water requirement should be optimal. Subsequently, this could affect fruit production by directly interacting with chlorophyll pigments involved in the synthesis of organic substances.

The 'Andreiaș' cultivar presented a different data compared to 'Van' and 'Margonia'. It recorded a decrease in the content of carotenoid pigments in the ripening phenophase of the fruit. In this situation there are no major differences regarding the content of pigments analyzed in the previous phenophases. This highlights a slight sensitivity of the cultivar to water stress occurring during this vegetation period.

## 4. Conclusions

The analysis of climatic conditions during the 2022 year showed an increase in the average annual temperature and a deficit of precipitation, which led to the installation of pedological, atmospheric and physiological drought.

The light intensity during the evaluated phenological stages varies depending on the cultivar and the temperature recorded at the time of their phenological development.

The content of leaf pigments has maximum values at the phenophase of fruit ripening, in all sweet cherry cultivars studied.

The content of photosynthetic pigments increased progressively starting with the flowering phenophase, ensuring a permanent photosynthetic activity. All sweet cherry cultivars evaluated showed high resistance properties in the climatic conditions of 2022.

## References

1. Asanica A., Badulescu L., Tudor V., 2015. The Synthesis Potential of Some Sweet Cherry Cultivars under the Influence of Different Rootstocks. Agriculture and Agricultural Science Procedia, 6: 102-109.
2. Balan V., 1978. Chlorophyll content and catalase activity in apple leaves depending on rootstock and doses of pre-planting fertilization. Questions of Intensive Horticulture, Kishinev, 25-29.
3. Corelli Grappadelli L., Lopez G., Manfrini L., Zibord M., Morandi B., Bastias R. and Losciale P., 2017. Conditioning the orchard light environment for greater efficiency and sustainability. Acta Hortic., 1177: 73-78.
4. FAO, 2021. https://www.fao.org/faostat/en/#data/QCL
5. Flore J.A., Layne D.R., 1999. Photoassimilate production and distribution in cherry. HortScience 34(6): 1015-1019.
6. Jităreanu C.D., 2007. Fiziologia plantelor. Ed. Ion Ionescu de la Brad, Iași (In Romanian).
7. Lichtenthaler H.K., 1987. Clorophylls and carotenoids: Pigments of photosynthetic biomembranes. Methods Wnzymol., 148: 350-382. https://doi.org/10.1016/0076-6879(87)48036-1.
8. Meier U., 2001. BBCH-Monograph. Growth stages of plants. Technical Report, Ed 2. Federal Biological Research Centre for Agriculture and Forestry (Braunschweig), 158.
9. Moreno M.A., Adrada R., Aparicio J., Betrá N.S., 2001. Performance of 'Sunburst' sweet cherry grafted on different rootstocks. The Journal of Horticultural Science And Biotechnology, 76(2): 167-173.
10. Ren J., Liang Sun, Jiefang Wu, Shengli Zhao, Canlei Wang, Yanping Wang, Kai Ji, Ping Leng, 2010. Cloning and expression analysis of cDNAs for ABA 8′-hydroxylase during sweet cherry fruit maturation and under stress conditions. Journal of Plant Physiology, Volume 167, Issue 17: 1486-1493, https://doi.org/10.1016/j.jplph.2010.05.027.

11. Shtai W., Tagliavini M., Holtz T., Abdelkader A. B., Petrillo M., Zanotelli D., Montagnani L., 2020. Total and diffuse light distribution within the canopy of an apple orchard as affected by reflective ground covers. Italus Hortus, 27: 69-84.
12. Todaria N.P., Thapliyal A.P., Purohit A.N., 1980. Altitudinal effects on chlorophyll and carotenoid contents in plants. Phytosynthetica, 14(2): 236-238.
13. Viljevac M., Dugalić K., Mihaljević I., 2013. Chlorophyll content, photosynthetic efficiency and genetic markers in two sour cherry *(Prunus cerasus* L*.)* genotypes under drought stress. Acta Botanica Croatica, 72(2): 221-235.
14. Welburn A.R., 1994. The Spectral Determination of Chloropylls a and b, as well as Total Carotenoids, Using Various Solvents with Spectrophotometers of Different Resolution. J. Plant Physion. 144: 307-313.

**Tables and Figures**

**Table 1. The climatic conditions (RSFG Iasi, Romania, 2022)**

| Month | Average annual temperature (°C) | | | Sum of annual precipitation (mm) | | |
|---|---|---|---|---|---|---|
| | Monthly av. | Multiannual | Deviation | Monthly sum | Multiannual | Deviation |
| **I** | 0.40 | -3.30 | +2.90 | 6.60 | 34.40 | -27.80 |
| **II** | 3.66 | -1.50 | +2.16 | 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 | +0.5 | 16.20 | 40.80 | -24.60 |
| **Average/sum** | **11.35** | **9.62** | **+1.74** | **440.34** | **517.80** | **-77.46** |

**Table 2. Light intensity in the main phenological stages in the studied sweet cherry cultivars (RSFG Iasi, Romania 2022)**

| Cultivar | Crown area | Average repetitions (lux) | | |
|---|---|---|---|---|
| | | 65BBCH** | 75BBCH** | 89BBCH** |
| **Van** | middle | 23,218 | 33,005 | 50,878 |
| | top | 26,000 | 39,667 | 53,382 |
| | overhead | 23,446 | 39,326 | 53,200 |
| | **Av. *** | **24,221.5$^{b}$** | **37,332.9$^{b}$** | **54,819.8$^{a}$** |
| **Andreiaș** | middle | 28,437 | 54,327 | 48,564 |
| | top | 31,890 | 57,448 | 57,456 |
| | overhead | 39,955 | 60,597 | 60,390 |
| | **Av.*** | **33,427.3$^{a}$** | **57,457.4$^{a}$** | **55,470.2$^{a}$** |
| **Margonia** | middle | 26,579 | 74,555 | 47,052 |
| | top | 30,641 | 53,525 | 51,245 |
| | overhead | 30,902 | 54,234 | 58,389 |
| | **Av.*** | **29,374.0$^{ab}$** | **59,104.8$^{a}$** | **52,228.9$^{a}$** |
| **Average** | | 29,007 | 51,854 | 53,395 |
| **Min.** | | 23,218 | 33,005 | 47,052 |
| **Max.** | | 39,954 | 74,555 | 60,390 |

*****-Different letters after the number correspond with statistically significant differences for *p* 5% - Duncan test.
**- BBCH-Phenological growth stages (Meier, 2001): 65 (full fowering); 75 (fruit growth); 89 (fruit ripening);

 DOI 10.33045/fgr.v39.2023.07

**Table 3. The content of pigments in different phenological stages and in different areas of the tree canopy (RSFG Iasi, Romania, 2022)**

| Cultivar | Pigments* | Phenological stage | | | | | |
|---|---|---|---|---|---|---|---|
| | | 65BBCH** | | 75BBCH** | | 89BBCH** | |
| | | Crown area | | | | | |
| | | exterior | interior | exterior | interior | exterior | interior |
| Van | C*a* | 8.69 | 8.53 | 8.16 | 8.49 | 10.68 | **10.85** |
| | C*b* | 2.56 | 2.66 | 2.94 | 3.06 | 4.15 | **4.25** |
| | C*a+b* | 11.25 | 11.19 | 11.10 | 11.55 | 14.83 | **14.90** |
| | C*x+c* | 2.83 | 2.75 | 2.37 | 2.39 | 2.77 | **2.85** |
| Andreiaș | C*a* | 7.91 | 8.82 | 6.66 | 8.01 | 8.09 | **9.12** |
| | C*b* | 2.46 | 2.78 | 2.63 | 3.01 | 3.14 | **3.41** |
| | C*a+b* | 10.37 | 11.61 | 9.29 | 11.02 | 11.23 | **12.52** |
| | C*x+c* | 2.57 | 2.77 | 2.29 | 2.58 | 2.36 | **2.38** |
| Margonia | C*a* | 8.40 | 8.05 | 8.18 | 8.44 | 11.43 | **12.32** |
| | C*b* | 2.54 | 2.43 | 2.38 | 2.94 | 4.14 | **4.31** |
| | C*a+b* | 10.94 | 10.47 | 10.57 | 11.38 | 15.57 | **16.63** |
| | C*x+c* | 2.72 | 2.55 | 2.44 | 2.13 | **3.16** | 3.04 |

*****-C*a*-Chlorophyll *a*; C*b*-Chlorophyll *b*; Ca+*b*-Green pigments; C*x*+*c*-Yellow pigments (xanthophylls and carotenoid pigments);
**- BBCH-Phenological growth stages (Meier, 2001): 65 (full fowering); 75 (fruit growth); 89 (fruit ripening);

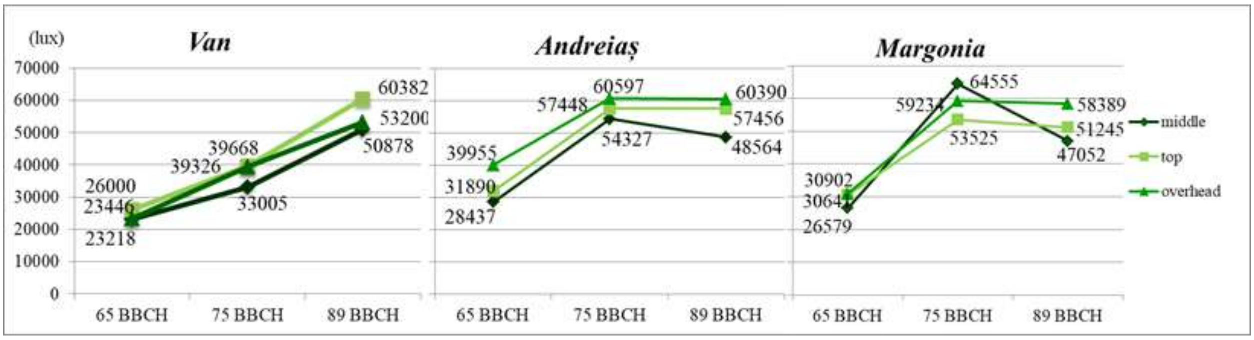


**Fig. 1.Light intensity dynamics in sweet cherry cultivars in different phenological stages**

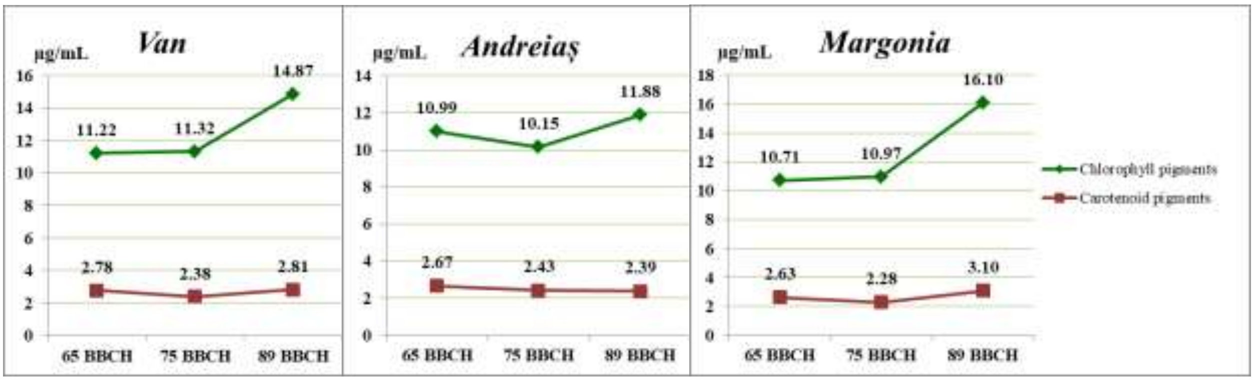


**Fig. 2. The average pigment content in the *Van* (a), *Andreiaș* (b) and *Margonia* (c) cultivars in different phenological stages**