

RESEARCH REGARDING THE DIURNAL DYNAMICS OF SOME PHYSIOLOGICAL PROCESSES IN *PERSICA VULGARIS* MILLER

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Abstract. The research studies regarding the diurnal dynamics of physiological processes were performed on the peach variety Springold cultivated in climate conditions of Oltenia region. The physiological analyses were performed, on mature leaves, in fruits growth phase (May 20, 2009) and the fruits maturation phase (June 20, 2009). At the analyzed peach leaves, the dynamics of photosynthesis and transpiration vary depending on the climatic conditions, registering a minimum in the morning, a maximum after lunch and a minimum toward the evening, but the recorded values are lower in fruits maturation phase. At the analyzed plant leaves, in the phase of fruit growth, which had a higher level of transpiration, there was recorded a lower water content. The content in chlorophyll pigments is higher in plant leaves analyzed in the fruit growth phase, being a positive correlation between the content in chlorophyll pigments and the intensity of photosynthesis.

Keywords: leaves, processes physiological, photosynthesis, transpiration.

Rezumat. Cercetări privind dinamica diurnă a unor procese fiziologice la *Persica vulgaris* MILLER. Cercetările privind dinamica diurnă a proceselor fiziologice s-au efectuat la soiul de piersic Springold cultivat în condițiile climatice din regiunea Olteniei. Analizele fiziologice s-au efectuat, la frunzele mature, în faza de creștere a fructelor (20 mai 2009) și în faza de maturare a fructelor (20 iunie 2009). La frunzele de piersic analizate s-a constatat că dinamica diurnă a fotosintezei și transpirației variază în funcție de condițiile climatice, prezentând un minim dimineața, un maxim după prânz și un minim spre seară, dar valorile înregistrate sunt mai mici în faza de maturare a fructelor. La frunzele plantelor analizate, în faza de creștere a fructelor, care au avut o intensitate a transpirației mare s-a înregistrat un conținut mai mic de apă. Conținutul în pigmenți clorofilieni este mai mare la frunzele plantelor analizate în faza de creștere a fructelor, între conținutul în pigmenți clorofilieni și intensitatea fotosintezei existând o corelație pozitivă.

Cuvinte cheie: frunze, procese fiziologice, fotosinteză, transpirație.

INTRODUCTION

The genetic centre of peaches is in China, from where it spread in the Middle East and from there in Europe, then moving to Africa and America.

Persica vulgaris MILLER presents lanceolate, petiolate leaves. It blooms in early spring, the flowers are solitary or arranged in pairs, pink and carmine-red. The size of fruit varies widely between cultivars and the wild form; it can be up to 7 cm in diameter and contains one seed. The fruit is spherical, hairy or bald (without piliferous), tasty and flavoury.

It is a species that tolerates cool climates, but may be affected by early spring frosts during flowering. The plants prefer well - drained soil.

Research conducted during the growing season has shown a seasonal dynamics characterized by: the intensity of the process of photosynthesis together with the leaf growth, achieving a maximum, which is followed by the decrease in the intensity of the process with the scaling of senescence (SAMS & FLORE, 1982).

At peach leaves, the photosynthesis maximum is achieved in late April and lasts until the first days of July (CAPPELINI & DETTORI, 1992).

The maximum of the peach photosynthetic intensity was recorded in the recently grown leaves and decreased gradually after reaching its maximum dimensions. The intensity of the process of photosynthesis in peach leaves varies between 8.0 and 15.8 $\mu\text{mol CO}_2/\text{m}^2/\text{s}$ (ANDERSEN & BRODBECK, 1988).

The intensity of the photosynthetic active radiation received by the tree leaves is higher near the edge of the crown and near the stem axis and decreases from the higher to the lower levels (MARINI & MARINI, 1983).

The diurnal dynamics of transpiration has a maximum at noon and a minimum during the night when cuticle transpiration occurs (BURZO et al., 1999).

It was discovered that shaded leaves have lower transpiration intensity compared to the sunny ones (CHALMERS et al., 1983).

Research conducted in peach on chlorophyll content from shaded and sunny leaves showed that shaded leaves have a higher chlorophyll content compared to the sunny ones (GAUDILLERE & MOING, 1992).

MATERIAL AND METHODS

Research studies regarding the diurnal dynamics of physiological processes were performed on peach variety Springold cultivated in the climatic conditions of Oltenia region (Banu Măracine, Dolj County).

This paper aims at studying the physiological processes (photosynthesis rate, transpiration rate) of peach plants in accordance with environmental factors (light, temperature).

The diurnal dynamics of photosynthesis and transpiration were made by using the portable analyzer LCi system, which enables automatic recording and other parameters (photosynthetic active radiations, leaf temperature, stomatal conductance etc.)

Measurement results were stored in files on memory cards. The obtained results were graphically represented and statistically interpreted.

The total water contents and that of dry substance were determined by the help of the drying stove - gravimetric method. The content of the chlorophyll pigments was estimates by Minolta SPAD 502 chlorophyll meter (the use of the chlorophyll meter SPAD is non-destructive method and permits repeated measurements).

RESULTS AND DISCUSSIONS

The growth process consists in increasing the fruit mass and volume and occurs in 2 stages: in the first stage the cell division takes place and in the second stage the cell extension occurs, which is manifested by the increase of cells and fruit. Fruit maturation is a process of qualitative accumulation, which determines the achievement of the traits characteristic to this particular variety (taste, flavour, quality, firmness).

Springold peach variety is part of the early variety group with harvest maturity in the second decade of June and the first decade of July. It is characterized by plants with high force, high productivity, and good resistance to frost. They bloom rather early, they are abundant and autofertile.

The fruit is medium in size (80-130 g), beautifully coloured in bright red and the flesh is yellow, with a slightly sweet flavour.

The physiological analyses were performed on mature leaves, in the fruit growth phase (May 20, 2009) and one month later, during the fruit maturation phase (June 20, 2009) (Figs. 1; 2).



Figure 1. Fruits growth phase at *Persica vulgaris*.
Figura 1. Faza de creștere a fructelor la *Persica vulgaris* (original).



Figure 2. Fruits maturation phase at *Persica vulgaris*.
Figura 2. Faza de maturare a fructelor la *Persica vulgaris* (original).

The photosynthesis intensity increases from early morning due to the increase of light intensity, temperature and the stomata opening level, it maintains itself constant until noon, then gradually decreases due to the decrease of light intensity, the accumulation of organic substances in chloroplasts, the gradual decrease of temperature, as well as the reduction of the opening degree of stomata.

In the leaves of the analyzed peach plants, one can notice an intensification of photosynthesis rate starting with the early hours of the morning (9 a.m.) when one can record values of $8.21 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits growth phase and of $7.72 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits maturation phase, their growth up until after lunch (1 p.m.) when one record values of $13.68 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits growth phase and $12.85 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits maturation phase and towards evening (5 p.m.) one can notice a gradual decrease, recording values of $10.25 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits growth phase and of $9.85 \mu\text{mol CO}_2/\text{m}^2/\text{s}$ in the fruits maturation phase (Fig. 3).

The transpiration intensity increases from dawn, when the opening of stomata takes place, presents a maximum value during the afternoon, when the temperature is higher and the air relative humidity is lower, and towards evening the reduction of the transpiration process takes place.

In the leaves of the *Persica vulgaris* MILLER one can observe an intensification of transpiration starting with the early hours of the morning (9 a.m.), when one can record values of 1.8 mmol H₂O / m²/s in the fruits growth phase and of 1.65 mmol H₂O / m²/s in the fruits maturation phase, their growth up until after lunch (1 p.m.), when one record values of 3.7 mmol H₂O / m²/s in the fruits growth phase and 3.25 mmol H₂O / m²/s in the fruits maturation phase and towards evening (5 p.m.) one can notice a gradual decrease, recording values of 2.52 mmol H₂O/m²/s in the fruits growth phase and of 2.26 mmol H₂O / m²/s in the fruits maturation phase (Fig. 4).

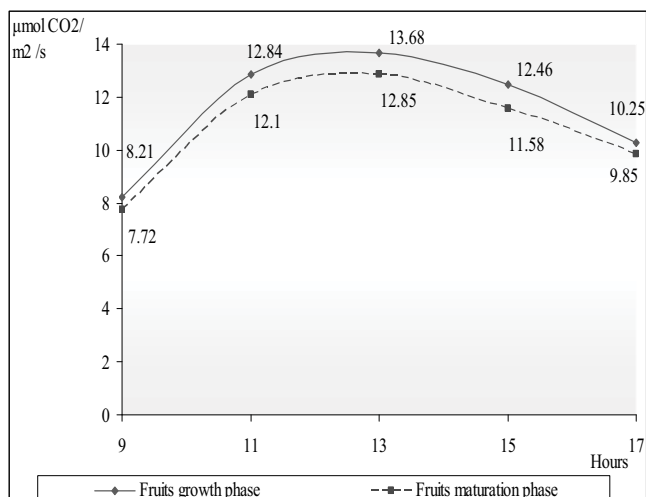


Figure 3. The diurnal dynamics of photosynthesis at the leaves of *Persica vulgaris* - Springold variety.

Figura 3. Dinamica diurnă a fotosintezei la frunzele de *Persica vulgaris* - soiul Springold.

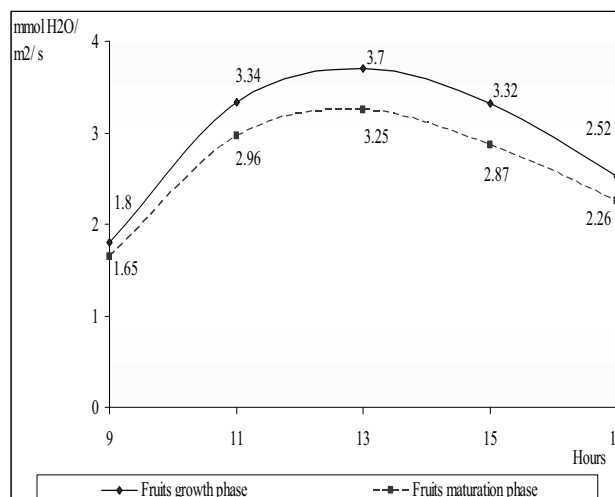


Figure 4. The diurnal dynamics of transpiration at the leaves of *Persica vulgaris* - Springold variety.

Figura 4. Dinamica diurnă a transpirației la frunzele de *Persica vulgaris* - soiul Springold.

At the peach plants one can notice an intensification of the photosynthetic active radiations present on the surface of the leaves starting with the early hours of the morning (9 a.m.), when one can record values of 1,182 μmol / m²/s in the fruits growth phase and of 1,224 μmol/m²/s in the fruits maturation phase, their growth up until after lunch (1 p.m.), when one record values of 1,460 μmol/m²/s in the fruits growth phase and 1,510 μmol/m²/s in the fruits maturation phase and towards evening (5 p.m.) one can notice a gradual decrease recording values of 1,340 μmol/m²/s in the fruits growth phase and of 1,415 μmol/m²/s in the fruits maturation phase.

The diurnal increase of the photosynthetic active radiations correlate with the increase of the photosynthesis rate and transpiration rate, but present different values in the fruits growth phase in comparison with the fruits maturation phase.

In the fruits growth phase, it was established a strong association between the photosynthesis rate and photosynthetic active radiations (Pearson correlation coefficient: $r = 0.97$), but also between the transpiration rate and photosynthetic active radiations (Pearson correlation coefficient: $r = 0.96$).

Linear regression made between the photosynthesis rate and photosynthetic active radiations shows a positive correlation between the 2 analyzed factors; the coefficient of determination (R^2) was 0.93 in the fruits growth phase and 0.90 in the fruits maturation phase (Fig. 5).

Regression made between the transpiration rate and photosynthetic active radiations shows a positive correlation; the coefficient of determination (R^2) was 0.93 in the fruits growth phase and 0.89 in the fruits maturation phase (Fig. 6).

In the phase of fruit maturation, due to the high temperature and the relatively low air humidity during summer days, the closing of the stomata occurs with the increase of the water shortage from the leaves, process leading to the decrease of physiological processes, in comparison with the fruit growth phase.

At the analyzed plants one can notice an increase of the leaf temperature starting with the early hours of the morning (9 a.m.), when one can record values of 23.7°C in the fruits growth phase and of 27.2°C in the fruits maturation phase, their growth up until after lunch (1 p.m.), when one record values of 28.6°C in the fruits growth phase and 32.4°C in the fruits maturation phase and towards evening (5 p.m.) one can notice a gradual decrease, recording values of 26.8°C in the fruits growth phase and of 30.1°C in the fruits maturation phase.

In the fruits growth phase, a very strong association was established between the photosynthesis rate and the leaf temperature (Pearson correlation coefficient: $r = 0.94$), but also between the transpiration rate and the leaf temperature (Pearson correlation coefficient: $r = 0.95$).

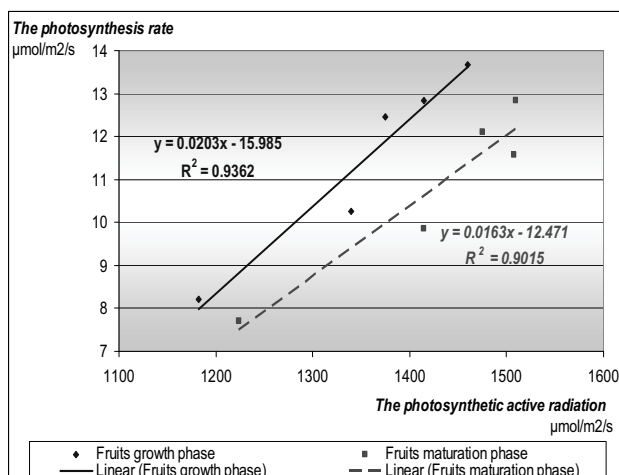


Figure 5. The correlation between the intensity of photosynthesis and the photosynthetic active radiation at the leaves of *Persica vulgaris* - Springold variety.

Figura 5. Corelații între intensitatea fotosintezei și radiația fotosintetic activă la frunzele de *Persica vulgaris* - soiul Springold.

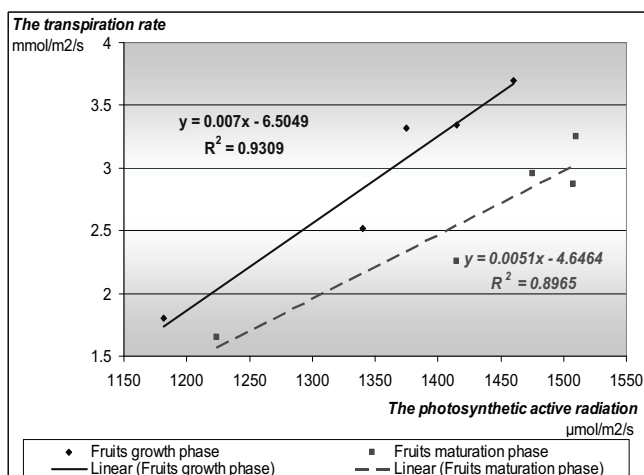


Figure 6. The correlation between the intensity of transpiration and the photosynthetic active radiation at the leaves of *Persica vulgaris* - Springold variety.

Figura 6. Corelații între intensitatea transpirației și radiația fotosintetic activă la frunzele de *Persica vulgaris* - soiul Springold.

Linear regression made between the photosynthesis rate and leaf temperature shows a positive correlation between the 2 analyzed factors; the coefficient of determination (R^2) was 0.89 in the fruits growth phase and 0.87 in the fruits maturation phase (Fig. 7).

Regression made between the transpiration rate and leaf temperature shows a positive correlation; the coefficient of determination (R^2) was 0.90 in the fruits growth phase and 0.86 in the fruits maturation phase (Fig. 8).

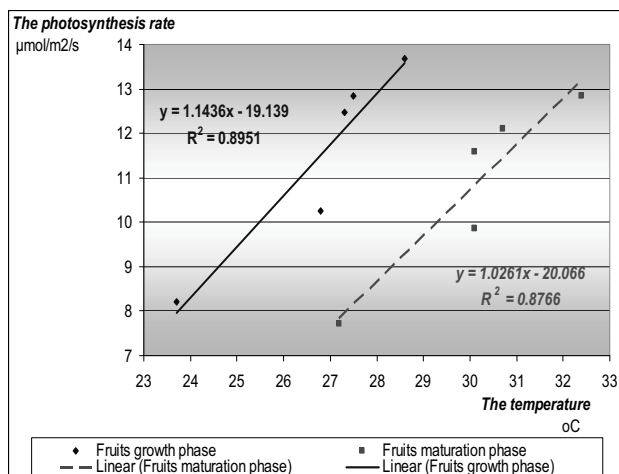


Figure 7. The correlation between the intensity of the photosynthesis and the leaf temperature at the *Persica vulgaris* - Springold variety.

Figura 7. Corelații între intensitatea fotosintezei și temperatura frunzei la *Persica vulgaris* - soiul Springold.

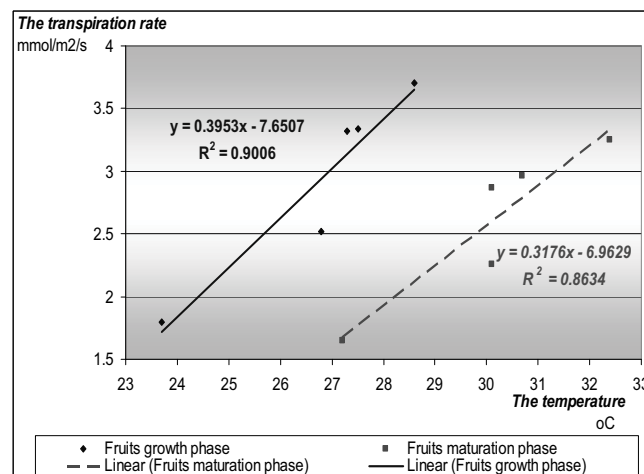


Figure 8. The correlation between the intensity of the transpiration and the leaf temperature at the *Persica vulgaris* - Springold variety.

Figura 8. Corelații între intensitatea transpirației și temperatura frunzei la *Persica vulgaris* - soiul Springold.

Stomatal conductance for CO_2 represents the value expression of stomatal permittivity for CO_2 passing trough.

The stomatal conductance for CO_2 increases until noon and decreases from then on, due to the reduction of the stomata opening level under the influence of high temperature and the decrease of relative air humidity.

Higher leaf temperatures cause the decrease of stomatal conductance and of temperature, lower stomatal conductance recording higher values. In hydric conditions of stress, the closing of stomata determines the increase of stomata resistance, the decrease of stomatal conductance and the reduction of photosynthetic intensity.

At the leaves of the peach plants, one can notice an intensification one of the stomatal conductance of CO_2 starting with the early hours of the morning (9 a.m.), when one can record values of $0.08 \text{ mol/m}^2/\text{s}$ in the fruits growth phase and $0.04 \text{ mol/m}^2/\text{s}$ in the fruits maturation phase, their growth up until after lunch (1 p.m.), when one record values of $0.28 \text{ mol/m}^2/\text{s}$ in the fruits growth phase and $0.23 \text{ mol/m}^2/\text{s}$ in the fruits maturation phase and towards evening (5 p.m.) one can notice a gradual decrease, recording values of $0.16 \text{ mol/m}^2/\text{s}$ in the fruits growth phase and $0.1 \text{ mol/m}^2/\text{s}$ in the fruits maturation phase.

In the fruits maturation phase a very strong association was established between the photosynthesis rate and stomatal conductance (Pearson correlation coefficient: $r = 0.96$), but also between the transpiration rate and stomatal conductance (Pearson correlation coefficient: $r = 0.97$).

Linear regression made between the photosynthesis rate and stomatal conductance shows a positive correlation between the 2 analyzed factors; the coefficient of determination (R^2) was 0.86 in the fruits growth phase and 0.93 in the fruits maturation phase (Fig. 9).

Regression made between the transpiration rate and stomatal conductance shows a positive correlation; the coefficient of determination (R^2) was 0.85 in the fruits growth phase and 0.94 in the fruits maturation phase (Fig. 10).

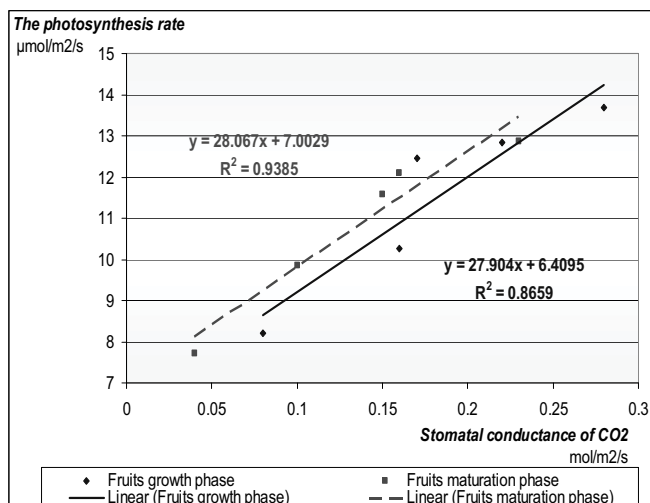


Figure 9. The correlation between the intensity of photosynthesis and the stomatal conductance at the leaves of *Persica vulgaris* - Springold variety.

Figura 9. Corelații între intensitatea fotosintezei și conductanța stomatală la frunzele de *Persica vulgaris* - soiul Springold.

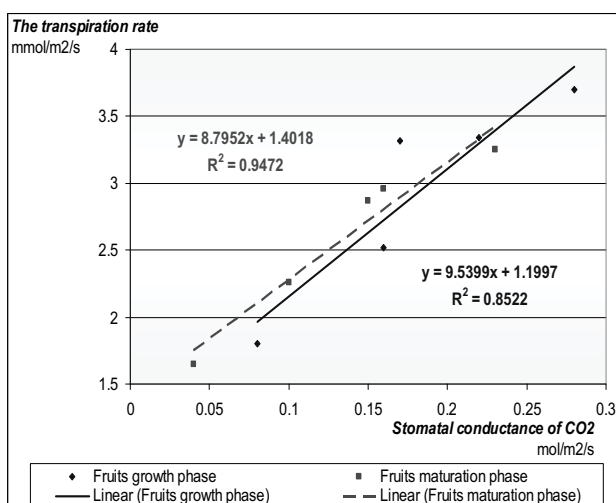


Figure 10. The correlation between the intensity of transpiration and the stomatal conductance at the leaves of *Persica vulgaris* - Springold variety.

Figura 10. Corelații între intensitatea transpirației și conductanța stomatală la frunzele de *Persica vulgaris* - soiul Springold.

At the analyzed plants, in the fruits maturation phase, present an increase of the water contents by 1.42% which is manifested by the increase of the cellular turgor and a decrease of the dry substance contents by 4.47% (Fig. 11).

The pigment chlorophyll content during the vegetation varies. The analyzed plants in the fruits maturation phase present a decrease of the chlorophyll content by 3.56%, a result of declining chlorophyll biosynthesis and of the gradual deterioration of the chlorophyllian pigments (Fig. 12).

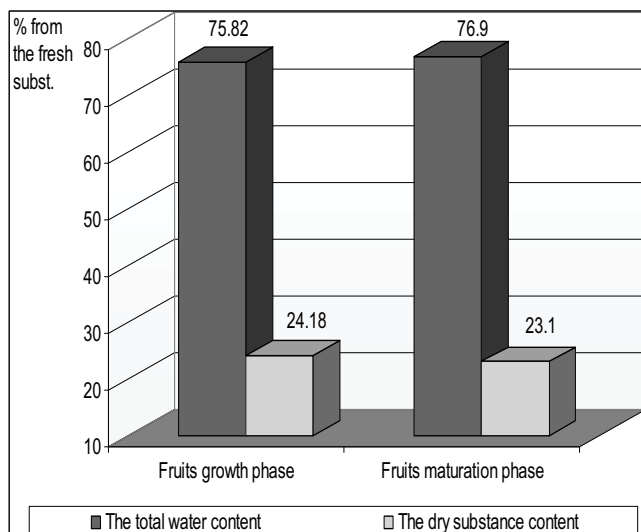


Figure 11. The water content and the dry substance content at the leaves of *Persica vulgaris* - Springold variety.

Figura 11. Conținutul de apă și conținutul de substanță uscată la frunzele de *Persica vulgaris* - soiul Springold.

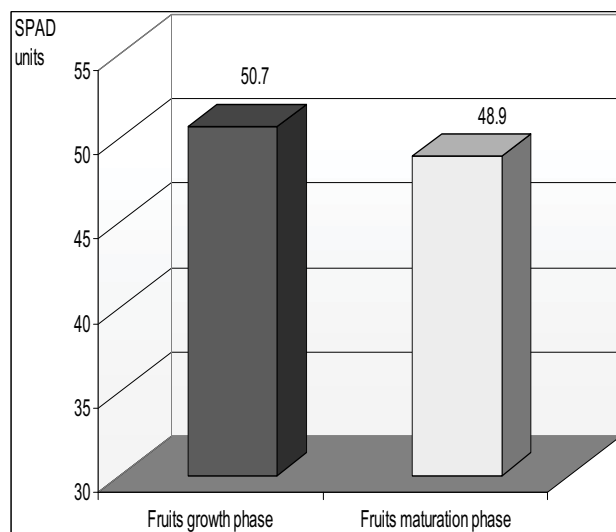


Figure 12. The chlorophyll content at the leaves of *Persica vulgaris* - Springold variety.

Figura 12. Conținutul de clorofilă la frunzele de *Persica vulgaris* - soiul Springold.

CONCLUSIONS

In *Persica vulgaris* MILLER, it was observed that the diurnal dynamics of the photosynthesis and transpiration presents a minimum in the morning, a maximum after lunch, and a minimum toward the evening, but the recorded values are lower in fruit maturation phase.

At the peach plants, according to the climatic conditions, it was established a positive correlations between the physiological process and photosynthetic active radiation incident on the surface of the leaf, leaf temperature, and stomatal conductance.

The water content during the vegetation varies. Thus, at the plant leaves analyzed in the fruit growth phase, which had a higher level of transpiration, there was recorded a lower water content.

The pigment chlorophyll content was higher in plant leaves analyzed in the fruits growth phase, being a positive correlation between the pigment chlorophyll content and the photosynthetic intensity. In fruit maturation phase observed a decrease in chlorophyllian pigment content due to the gradual decline of their biosynthesis.

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