INFLUENCE OF TREATMENTS WITH FUNGICIDES ON THE PHYSIOLOGICAL PROCESSES IN *Persica vulgaris* MILLER ATTACKED BY *Taphrina deformans* (BERK.) TUL.

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Abstract. Research studies regarding the influence of treatments with fungicide on the physiological processes were performed on peach variety Harken cultivated in the climatic conditions in Oltenia region (Banu Mărăcine, Dolj). The physiological analyses were performed in a first phase (May 2nd 2010) on the plants attacked by *Taphrina deformans* (BERK.) TUL. and in a second phase, after a month (June 5th 2010) during which there have been two sessions of treatment with contact fungicide Dithane M 45-0.2%. It has been established at the peach leaves that the diurnal dynamics of photosynthesis and transpiration varies according to climatic conditions, thus recording lower values in the morning, higher values in the afternoon and lower ones towards the evening. The photosynthesis intensity records lower values while the transpiration intensity has higher values at the attacked leaves, compared to the plant leaves after having been treated with fungicides. There has been recorded a lower water content at the leaves attacked by the pathogen because they registered a higher transpiration intensity. The content in chlorophyll is higher at the analysed leaves after performing treatments with fungicide, thus a positive correlation between this content and the photosynthesis intensity being revealed.

Keywords: attacked leaves, fungicide, peach, physiological processes, pathogen.

Rezumat. Influenţa tratamentelor cu fungicide asupra proceselor fiziologice la *Persica vulgaris* MILLER atacat de *Taphrina deformans* (BERK.) TUL. Cercetările privind influenţa fungicidelor asupra proceselor fiziologice s-au efectuat la soiul de piersic Harken cultivat în condiţiile climatice din regiunea Olteniei (Banu Mărăcine, Dolj). Analizele fiziologice s-au realizat, în prima etapă (2.05.2010) la plantele atacate de *Taphrina deformans* (BERK.) TUL. şi în a doua etapă, după o lună de zile (5.06.2010), interval de timp în care s-au efectuat două tratamente cu fungicidul de contact Dithane M 45-0,2%. La frunzele de piersic analizate s-a constatat că dinamica diurnă a fotosintezei şi transpiraţiei variază în funcţie de condiţiile climatice, prezentând valori scăzute dimineaţa, valori maxime după prânz şi valori scăzute spre seară. Intensitatea fotosintezei a înregistrat valori mai scăzute, iar intensitatea transpiraţiei valori mai mari în frunzele atacate, comparativ cu frunzele plantelor după ce s-au efectuat tratamente cu fungicide. La frunzele atacate de patogen, care au avut o intensitatate a transpiraţiei mare s-a înregistrat un conţinut mai scăzut de apă. Conţinutul în clorofilă este mai mare la frunzele analizate după efectuarea tratamentelor cu fungicide, între conţinutul în clorofilă şi intensitatea fotosintezei existând o corelaţie pozitivă.

Cuvinte cheie: frunze atacate, fungicid, piersic, procese fiziologice, patogen.

INTRODUCTION

The peach is originally from China, from where it spread in the Middle East and from there in Europe.

Persica vulgaris MILLER presents lanceolate leaves, the flowers are solitary or arranged in pairs, are pink and carmine-red, the fruit is spherical, hairy or bald tasty and flavoury. The peach tree requires light and heat in abundance and the most favourable temperature in order to bloom is around 13 to 16°C. It is a species that tolerates cool climates, but may be affected by early spring frosts during blooming.

The start of the vegetation for peach trees occurs in the last period of March or the first period of April. The intense growth of the offspring takes place in the last period of April, in May and the first period of June.

The peach leaf curl, caused by *T. deformans*, is an important disease generating quantitative and qualitative yield losses. This is very widespread in all peach growing areas around the world (PONTI & SPADA, 1997).

The area is favourable to peach culture in southern, eastern and south western Romania, and the best peach cultivation favours the emergence and evolution of the *T. deformans.* The disease is frequently encountered in the peach crop in our country, the symptoms being developed at the end of April to early May.

The net photosynthetic activity is subjected to seasonal changes and to diurnal changes, which are mainly influenced by the stage of shoot development, leaf ageing, hormones and carbohydrates accumulation in leaves, as well as by light intensity fluctuations, leaf temperature, air temperature and humidity (LAKSO, 1985).

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

Research regarding the diurnal dynamics of the process of photosynthesis at peach leaves revealed a maximum in the early hours of illumination of leaves; it remains constant through the period of leaf illumination and decreases when darkness sets in (CREWS *et al.*, 1975).

The intensity of the process of photosynthesis in peach leaves varies between 8.0 and 15.8 μmol $CO_2/m^2/s$ (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. At the peach tree, the leaves formed at various distances from the centre of the tree did not have high differences of chlorophyll content, but the inner ones have a higher content as compared to the leaves in the outer branches (MARINI & MARINI, 1983).

The 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).

The young leaves have the highest intensity of the transpiration process and as they get older, the transpiration intensity decreases, the lower values being recorded at senescent leaves (BURZO *et al*., 1999).

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

MATERIAL AND METHODS

The research studies regarding of the physiological changes produced by the *Taphrina deformans* (BERK.) TUL. were performed in the peach varieties **Harken** cultivated in the climatic conditions in Oltenia region (Banu Mărăcine, Dolj).

The peach varieties **Harken** is an extremely vigorous tree and requires fertile, well drained soils. It is the best flavoured peach, is hardy and widely adaptable. They also require heavier pruning than any other fruit trees to maintain size and encourage new growth. This peach ripens in early August. The fruits are large, spherical and are very sweet.

The physiological processes were established with the ultra-compact photosynthesis measurement system - LCi. The results obtained were graphically represented and statistically interpreted.

The water contents and that of dry substance were determined by the help of the drying stove - gravimetric method. The chlorophyll content was estimates by Minolta SPAD 502 chlorophyll meter.

For the estimate of the attack it was used the calculation formulae by SĂVESCU & RAFAILĂ, 1978.

The treatment with the fungicide **Dithane** M 45-0.2% was applied on the leaves in two phases, for a month, starting from May 2nd 2010, during the vegetation period, after the emergence of attack symptoms.

Dithane M 45 is a contact fungicide with a wide action spectrum. It has a good persisting effect remaining on the treated area from 7 to 10 days, depending on local conditions.

RESULTS AND DISCUSSIONS

T. deformans presents mycelium, septal, truncated and grows intercellular. On both sides of the leaf it is formed ovoid or cylindrical asca, and each asca contains 8 ascospores, spherical, yellowish or hyaline**.** By germination ascospores produces a haploid mycelium, living on bark saprophytes on the bark of branches. On this mycelium, in the spring, there are formed flush of cells, which come on young leaves, copulate, resulting in binuclear cells, which by germination produce filaments of infection entering in the intercellular tissue spaces.

Fungus attacks the leaves, young twigs and the favourable fruits, too. On the leaf the first symptoms appear at the end of April early May, when parenchyma between stems increases stronger than ribs. The leaves are hypertrophied and have a characteristic pink colour, presenting on both sides a dirty-white powder, consisting asca of the fungus. After several days, the leaves acquire a brown coloration, and the second decade of May they can fall (Fig. 1).

Figure 1. The *Persica vulgaris* - **Harken** variety attacked by *Taphrina deformans.* / Figura 1. *Persica vulgaris* - soiul **Harken** atacat de *Taphrina deformans* (original).

Figure 2. The *Persica vulgaris* - **Harken** variety after treatments with fungicide. / Figura 2. *Persica vulgaris* - soiul **Harken** după efectuarea tratamentelor cu fungicid (original).

The affected flowers present hypertrophied petals. On fruit the attack occurs in May, when reddish spots appear, slightly prominent, with irregular edges. As the fruits grow, the tissues are attacked, become brownish and crack. Although this fungus can infect the fruit, most losses are due to reduced vigour caused by defoliation.

The fungus *Taphrina deformans* causing leaf curl on peaches is usually controlled with fungicides applied in the period between leaf fall and bud break, or in the period of vegetation, till at the formation of fruits.

After performing the two sessions of treatments with **Dithane** M 45-0.2% fungicide on the leaves with specific symptoms (hypertrophy and pink hue), the attack ceased. The attacked leaves generally dried out and fell, thus taking place the regeneration of the foliate apparatus with positive effect on their chlorophyll content (Fig. 2). The fungicide treatments that were applied on the leaves had a positive influence on the subsequent tree growth and development.

The physiological analyses were performed on leaves attacked by *Taphrina deformans* (BERK.) TUL. (May 2nd 2010) and one month after attack (June 5th 2010), time in which there were made two treatments with foliar fungicides *Dithane* M 45 – 0.2%.

The estimation of the attack (frequency, intensity and degree of attack) caused by the *Taphrina deformans* at the peach - **Harken** variety on May 2nd 2010 is presented in figure 3.

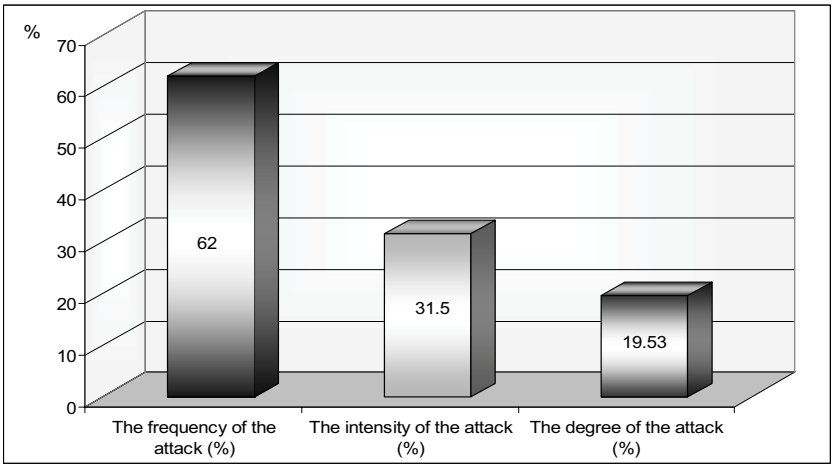

Figure 3. The estimate of the attack produced by *Taphrina deformans* in the peach - **Harken** variety. /
Figura 3. Estimarea atacului produs de *T. deformans* la piersic - soiul **Harken**.

The diurnal dynamics of photosynthesis in the attacked leaves is similar to that in the plant leaves analysed one month after attack, time in which there were made treatments with foliar fungicide, but the recorded values are lower in comparison with these as a result of the reduction of the assimilation surface, as well as the of the inhibition of several biochemical reactions of the photosynthesis (Fig. 4).

The diurnal dynamics of transpiration in the attacked leaves is similar to that in the leaves analysed one month after attack, time in which there were made treatments with fungicide, but the recorded values are higher in comparison with these as a result of the leaves hypertrophy and malfunctioning of the stomatic apparatus as a result of the action of the pathogen (Fig. 5).

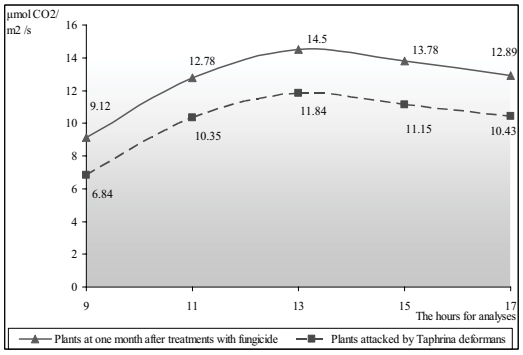

Figure 4. The diurnal dynamics of photosynthesis at the peach leaves - **Harken** variety. / Figura 4. Dinamica diurnă a fotosintezei la frunzele de piersic - soiul **Harken**.

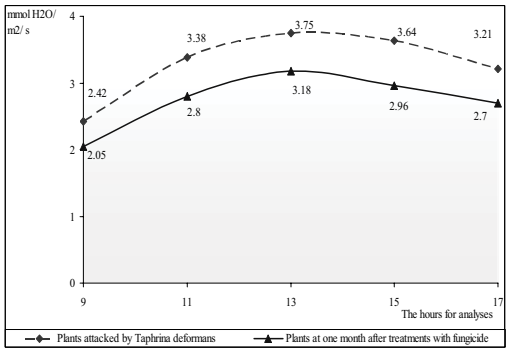

Figure 5. The diurnal dynamics of transpiration at the peach leaves - **Harken** variety. / Figura 5. Dinamica diurnă a transpiraţiei la frunzele de piersic - soiul **Harken**.

The photosynthesis intensity and transpiration intensity depend on the light radiation received by leaves. At the peach leaves 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 1210 µmol/m^2/s in the attacked

leaves by *T. deformans* and of 1180 µmol/m^2/s in the leaves one month after treatments with fungicide, their growth up until after lunch (1 p.m.) when one record values of 1530 µmol/m^2/s in the attacked leaves and µmol/m^2/s one month after treatments with fungicide and towards evening (5 p.m.) one can notice a gradual decrease recording values of 1475 µmol/m^2/s in the attacked leaves and of 1386 µmol/m^2/s after treatments with fungicide.

The increase of the photosynthetic active radiations correlates with the increase of the photosynthesis and transpiration, but presents different values in the attacked leaves as a result of several structural modifications appeared in the host plants under the damaging action of the pathogen, in comparison with the leaves one month after treatments with fungicide.

Linear regression made between the rate of photosynthesis and photosynthetic active radiations shows a good positive correlation between the two analysed factors; the coefficient of determination (R^2) was 0.97 for the leaves one month after treatments with fungicide and 0.95 for the attacked leaves (Fig. 6).

Linear regression made between the rate of transpiration and photosynthetic active radiations shows a good positive correlation; the coefficient of determination (R^2) was 0.96 for the leaves one month after treatments with fungicide and 0.93 for the attacked leaves (Fig. 7).

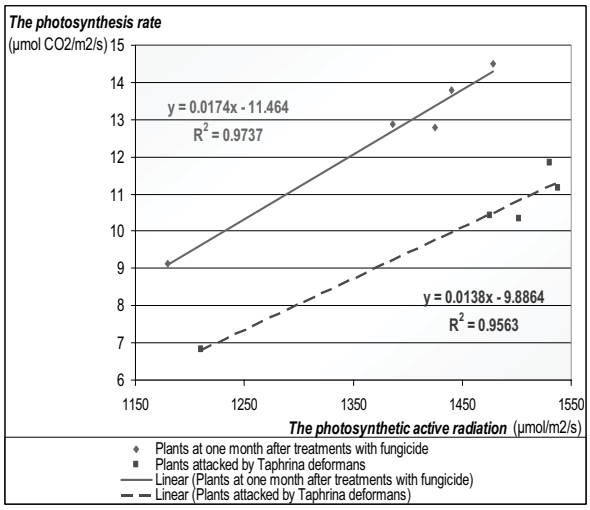

Figure 6. The correlation between the intensity of photosynthesis and the photosynthetic active radiation at the peach leaves - **Harken** variety. / Figura 6. Corelaţii între intensitatea fotosintezei şi radiaţia fotosintetic activă la frunzele de piersic - soiul **Harken**.

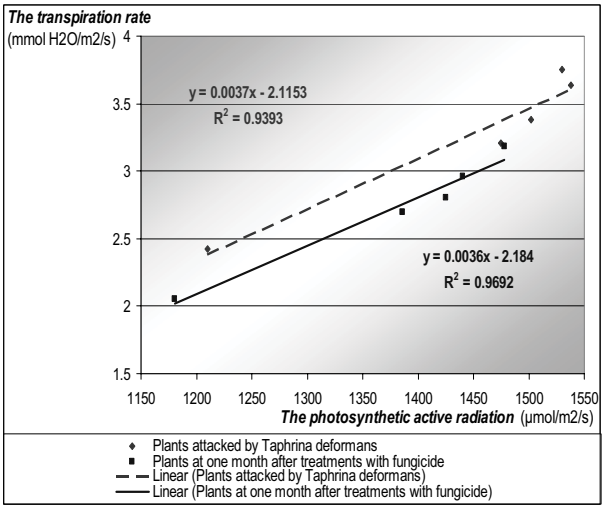

Figure 7. The correlation between the intensity of transpiration and the photosynthetic active radiation at the peach leaves - **Harken** variety. / Figura 7. Corelaţii între intensitatea transpiraţiei şi radiaţia fotosintetic activă la frunzele de piersic - soiul **Harken**.

At the peach leaves 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 21.5^{o}C in the attacked leaves and of 25.5^{o}C in the leaves one month after treatments with fungicide, their growth up until after lunch (1 p.m.), when one record values of 26.8^{o}C in the attacked leaves and 30.2^{o}C in the leaves one month after treatments and towards evening (5 p.m.) one can notice a gradual decrease, recording values of 24.4^{o}C in the attacked leaves and of 27.6^{o}C in the leaves one month after treatments.

Linear regression made between the rate of photosynthesis and leaf temperature shows a good positive correlation between the two analysed factors; the coefficient of determination (R^2) was 0.87 for the leaves one month after treatments with fungicide and 0.90 for the attacked leaves (Fig. 8).

Linear regression made between the rate of transpiration and leaf temperature shows a good positive correlation; the coefficient of determination (R^2) was 0.94 for the leaves one month after treatment with fungicides and 0.91 for the attacked leaves (Fig. 9).

The stomatal conductance for CO_2 increases until noon and decreases from then on due to the reduction of the stomata opening level. At the leaves of the peach plants one can notice an intensification of the stomatal conductance of CO_2 starting with the early hours of the morning (9 a.m.), when one can record values of 0.07 µmol/m^2/s in the attacked leaves and 0.1 µmol/m^2/s in the leaves one month after treatments with fungicide, their growth up until after lunch (1 p.m.), when one record values of 0.21 µmol/m^2/s in the attacked leaves and 0.3 µmol/m^2/s in the leaves after treatments and towards evening (5 p.m.) one can notice a gradual decrease, recording values of 0.12 µmol/m^2/s in the attacked leaves and 0.17 µmol/m^2/s in the leaves after treatments.

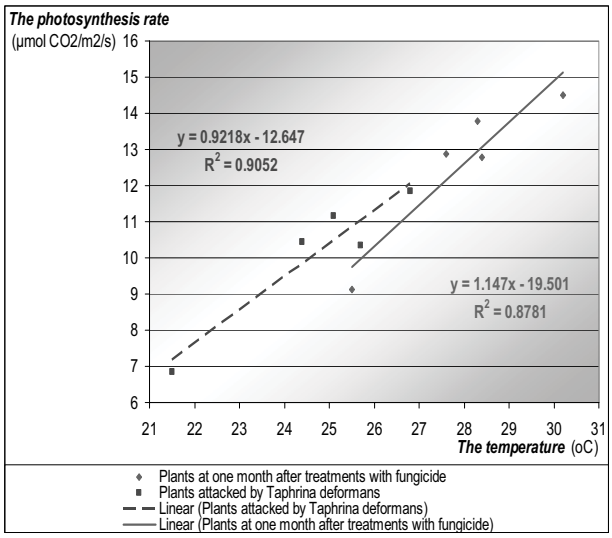

Figure 8. The correlation between the intensity of photosynthesis and the leaf temperature at the peach leaves - **Harken** variety. / Figura 8. Corelaţii între intensitatea fotosintezei şi temperatura frunzei la frunzele de piersic - soiul **Harken**.

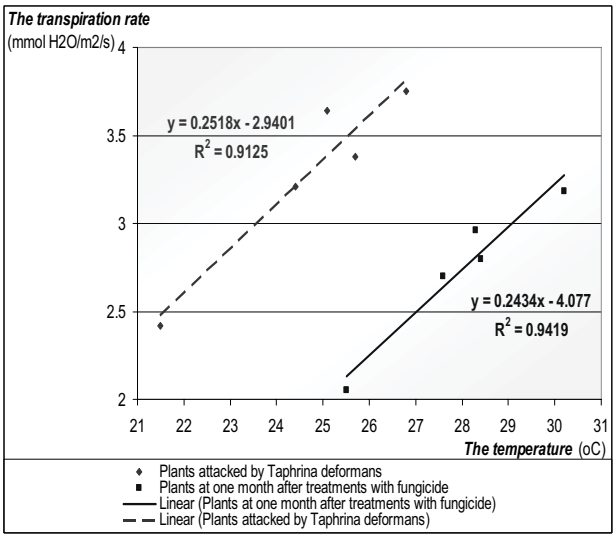

Figure 9. The correlation between the intensity of transpiration and the leaf temperature at the peach leaves - **Harken** variety. / Figura 9. Corelaţii între intensitatea transpiraţiei şi temperatura frunzei la frunzele de piersic - soiul **Harken**.

Linear regression made between the rate of photosynthesis and stomatal conductance of CO_2 shows a positive correlation between the two analysed factors; the coefficient of determination (R^2) was 0.81 for the leaves one month after treatments with fungicide and 0.73 for the attacked leaves (Fig. 10).

Linear regression made between the rate of transpiration and stomatal conductance of CO_2 shows a positive correlation; the coefficient of determination (R^2) was 0.90 for the leaves one month after treatments with fungicide and 0.81 for the attacked leaves (Fig. 11).

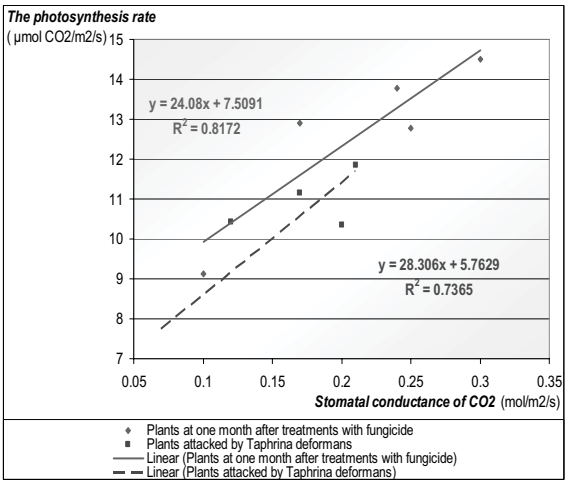

Figure 10. The correlation between the intensity of photosynthesis and the stomatal conductance at the peach leaves - **Harken** variety. / Figura 10. Corelaţii între intensitatea fotosintezei şi conductanţa stomatală la frunzele de piersic - soiul **Harken**.

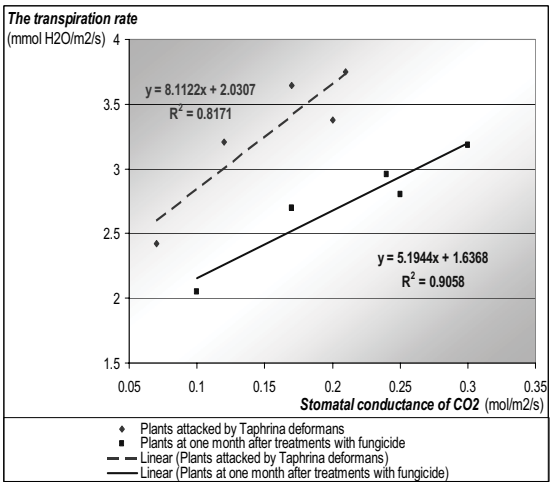

Figure 11. The correlation between the intensity of transpiration and the stomatal conductance at the peach leaves - **Harken** variety. / Figura 11. Corelaţii între intensitatea transpiraţiei şi conductanţa stomatală la frunzele de piersic - soiul **Harken**.

The leaves attacked by *Taphrina deformans* present a lower water content and a higher dry substance content, compared with the leaves analysed after treatments with fungicide (Fig. 12).

In the leaves attacked by the pathogen it is recorded a lower chlorophyll content as a result of the reductions of biosynthesis chlorophyll and the deterioration of the chlorophyllian pigments, in comparison with the leaves analysed after treatments with fungicide (Fig. 13).

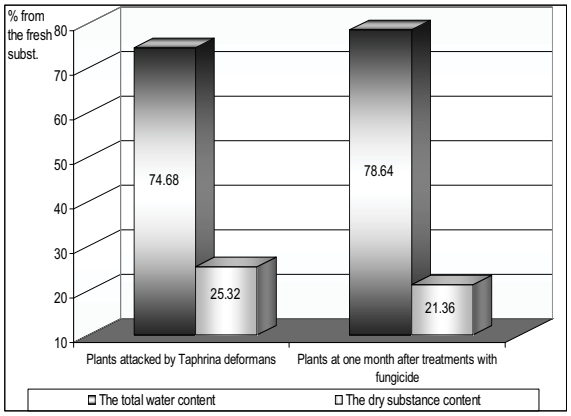

Figure 12. The water content and the dry substance content at the peach leaves - **Harken** variety. / Figura 12. Conţinutul de apă şi conţinutul de substanţă uscată la frunzele de piersic - soiul **Harken**.

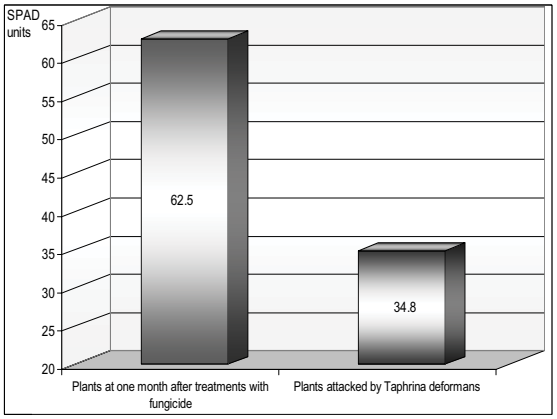

Figure 13. The chlorophyll content at the peach leaves - **Harken** variety. / Figura 13. Conţinutul de clorofilă la frunzele de piersic - soiul **Harken**.

CONCLUSIONS

In *Persica vulgaris* it has been noticed that 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 photosynthesis intensity presents values that are lower and the transpiration intensity presents values that are higher, in the peach leaves attacked by *T. deformans*, compared with the leaves analysed after treatments with fungicide. At the peach plants, according to the climatic conditions, it has been established a good positive correlation between the physiological process (photosynthesis and transpiration) and photosynthetic active radiation incident on the leaf surface, leaf temperature and stomatal conductance.

In the plant leaves attacked by the pathogen, which had a higher level of transpiration, there has been recorded a lower water content and a higher dry substance content, compared with leaves analysed after the treatments performed.

The chlorophyllian pigment content was higher in plant leaves analysed after treatments with fungicide, compared with the leaves attacked by pathogen, there being a positive correlation between the chlorophyllian pigment content and the photosynthesis intensity.

REFERENCES

ANDERSEN P. C. & BRODBECK B. V. 1988. *Water relations and net CO_2 assimilation of peach leaves of different ages.* Journal of the American Society for Horticultural Science. **113**(2): 242-248.

BURZO I., TOMA S., OLTEANU I., DEJEU L., DELIAN ELENA, HOZA D. 1999. *Fiziologia plantelor de cultură*. Întreprinderea Editorial Poligrafică „Ştiinţa", Chişinău. **3**. 440 pp.

CAPPELLINI P. & DETTORI M. T. 1992. *The photoynthetic activity of different peach genotypes.* Acta Horticulturae. **315**: 71-80.

CHALMERS D. J., OLSSON K. A., JONES T. R. 1983. *Water relations of peach trees and orchards.* In: T.T. Kozlowski (Ed.) Water deficits and plant growth. Academic Press. London. **7**: 197-232.

CREWS C. E., WILLIAMS S. L., VINES H. M. 1975. *Characteristics of photosynthesis in peach leaves*. Planta. **126**: 97-104.

GAUDILLERE J. P. & MOING A. 1992. *Photosynthesis of peach leaves: light adaptation, limiting factors and sugar content.* Acta Horticulturae. **315**: 103-109.

LAKSO A. N. 1985. *The effects of water stress potential on physiological processes in fruit crops*. Acta Horticulturae. **171**: 275-290.

MARINI R. P. & MARINI M. C. 1983. *Seasonal changes in specific leaf weight, net photosynthesis, and chlorophyll content of peach leaves as affected by light penetration and canopy position.* Journal of the American Society for Horticultural Science. **108**: 609-613.

PONTI I. & SPADA G. 1997. *Difendiamoil pesco dalla bolla.* Terra e Vita. **38**(15): 48-52.

SĂVESCU A. & RAFAILĂ C. 1978. *Prognoza în protectia plantelor*. Edit. „Ceres". Bucureşti. 354 pp.

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Received: March 27, 2012
Accepted: June 23, 2012