THE INFLUENCE OF FUNGICIDES ON THE PHYSIOLOGICAL PROCESSES' INTENSITY IN *MALUS DOMESTICA* BORKH. ATTACKED BY *PODOSPHAERA LEUCOTRICHA* (*ELLIS & EVERH*.) E. S. SALMON

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ABSTRACT

In the analized leaves of the *Malus domestica* Borkh., it has been noticed that the photosynthesis and transpiration intensity vary, during the day, according to climatic conditions, presenting lower values in the morning, higher values in the afternoon and lower values towards the evening, but the recorded values are higher for the leaves plant after performing fungicide treatments, in comparison with the leaves plant attacked by *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon (not treated with fungicide).

At the leaves of the apple tree analysed after performing treatments with fungicide a higher water content and clorophyll content was registered, compared to attacked leaves by pathogen.

INTRODUCTION

Malus domestica Borkh. is native to central Asia, being one of the oldest and most widespread fruit species.

Apple culture is of particular economic, social and food importance to humans. It comes from the spontaneous (natural) consecutive crossing over time of many wild apple species first existing in central Asia and Europe (Tănăsescu, 2005).

Malus domestica Borkh. grows in all countries with temperate, warm climates. The plant has a thick trunk with smooth gray bark in the beginning, which then exfoliates in irregular plates. The apple crown consists of both extended branches and of shorter ones with fruit (Nicolae I., 2010).

Podosphaera leucotricha (apple powdery mildew) is a very destructive pathogen, it produces damages in fruit orchards but also severe attacks are recorded in nursery also.

Powdery mildew infects young tissues in the plant, starting from buds, blossoms leaves until twigs and even branches causing specific symptoms. The environmental conditions have a major role in the disease epidemics but also the biological reserve, susceptibility of cultivars (Jakab-Ilyefalvi Zs., 2016).

Research conducted on the diurnal dynamics of the process of photosynthesis suggests that it has a maximum in the early hours of illumination of leaves, remains constant throught the period of leaf illumination and decreases when darkness sets in (Crews et al., 1975).

The intensity of the photosynthesis process is higher in the case of the apple leaves located at a height of 1.8 m compared with those located at 1.0 m above the ground (Corelli and Sansavini, 1989).

The intensity of transpiration process at apple has higher values in the full flowering stage and gradually decreases after 100 days after petal fall (Rom and Ferree, 1986).

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).

Intensity of transpiration process commensurate increases with that of photosynthesis, both processes are dependent on solar radiation intensity (Bignami and Natali, 1992).

MATERIAL AND METHOD

Researches regarding influence of fungicides on the physiological processes intensity in *Malus domestica* Borkh. attacked by *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon were performed on *Jonagold* apple varieties cultivated in the climatic conditions in Oltenia region.

Malus domestica Borkh. presents the root varied in shape, size and growth rate depending on the variety, the stem is high with the strongly branched crown, the leaves are ovate, elliptical, obovate or elongate-obovate, crenate-serrate on the edges.

The flowers are white-pink, grouped in umbeliform tops, and the fruits are globular, varying in size and color depending on the variety.

Jonagold apple varieties comes from the *Jonathan* x *Golden* variety.

It is a variety with vigorous growth, the fruit is large spherical, with a deep red color, smooth, waxy. The flesh of the fruit has a yellowish-white color, with an aromatic taste. It reaches harvesting maturity in the second half of September, respectively the beginning of October.

Shavit F 72 WP (0.2%) fungicide was applied on the leaves, in five phases, at 10 days interval (May 21th 2018, May 31th 2018, June 10th 2018, June 20th 2018 and June 30th 2018) and the physiological analyzes were performed comparatively, both for the leaves of the plants treated with fungicide and also for the attacked leaves by pathogen (not treated with fungicide).

Shavit F 72 WP is a complex fungicide, containing two active substances (triadimenol and folpet), with systemic and contact action. Shavit F 72 is applied starting from the pink button phase to the physiological fall of the fruit (June), at warning or preventive.

The estimate of the attack was made using the calculation formulae by (Săvescu and Rafailă, 1978).

The physiological processes' intensity were determined with the ultra compact photosynthesis measurement system LCi, system which enables automatic recording and other parameters (photosynthetic active radiations, leaf temperature, stomatal conductance etc.).

The water contents and that of dry substance were determined by the gravimetric method.

The chlorophyll content was estimates by Minolta SPAD 502 chlorophyll meter.

RESULTS AND DISCUSSIONS

The attack produced by *Podosphaera leucotricha* is manifested throughout the vegetation period on buds, leaves, inflorescences, shoots and fruits.

The attacked organs are covered by the whitish mycelium which gradually becomes yellowish, powdery, as a result of the formation of conidiophores with conidia.

The flower buds, as well as the vegetative ones from the fruit formations, infected in the previous year, do not evolve normally, they are covered with a dusty, white flour with a flourish appearance, they are reddened, dry and fall.

The attack on the young leaves leads to slight deformation and bending towards the top, these are less elastic, become brittle and dry early (Fig. 1).

The flowers attacked by the fungus have elongated, greenish petals, are sterile, dry and fall.

Fruit attack is very rare and manifests as more or less deep irregular cracks, covered with a whitish felt.

Podosphaera leucotricha (Ellis & Everh.) E. S. Salmon has an ectoparasitic, hyaline, septate and branched mycelium that differentiates haustors that enter the epidermal cells. Conidiophores are simple, long, carrying single-celled conidia, ellipsoidal in shape (Fig. 2).

Fig. 1. The leaves of the apple tree (*Malus domestica* Borkh.) attacked by *Podosphaera leucotricha* - Original.

Globulose and brown cleistothecium are formed on the mycelium, with 3-5 simple dichotomous appendages branched at the tip. Cleistothecia contains an asca with 8 ascospores ellipsoidal, unicellular.

The fungus goes through winter as mycelium of resistance in germs and sprouts, cleistothecia on twigs or on attacked leaves, conidia from the previous year remaining on the branches - insertions and attacked germs (Nicolae Mariana, Nicolae I., 2009).

The physiological analyses were performed on July 10th 2018, both for leaves treated with *Shavit* F 72 WP (0.2%) fungicide and also for the attacked leaves by pathogen (not treated with fungicide).

The estimation of the attack (frequency, intensity and degree of attack) caused by *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon at the leaves apple tree is presented in Fig. 3.

Fig. 2. *Podosphaera leucotricha* - conidiophores with conidia (oc. 10 x ob. 40) - Original.

The photosynthesis intensity in the leaves of the apple tree attacked by the the apple tree in which treatments have been performed, but the recorded values are lower in comparison with these, due to the reduction of the surface of assimilation by covering them by the mycelium of the fungus (Fig. 4).

The transpiration intensity in the attacked leaves is similar to that in the leaves in which treatments have been performed, but the recorded values are lower due to the covering of the ostioles of the stomata by the mycelium of the pathogen and the malfunctioning of the stomatic apparatus under the harmful action of the pathogen (Fig. 5).

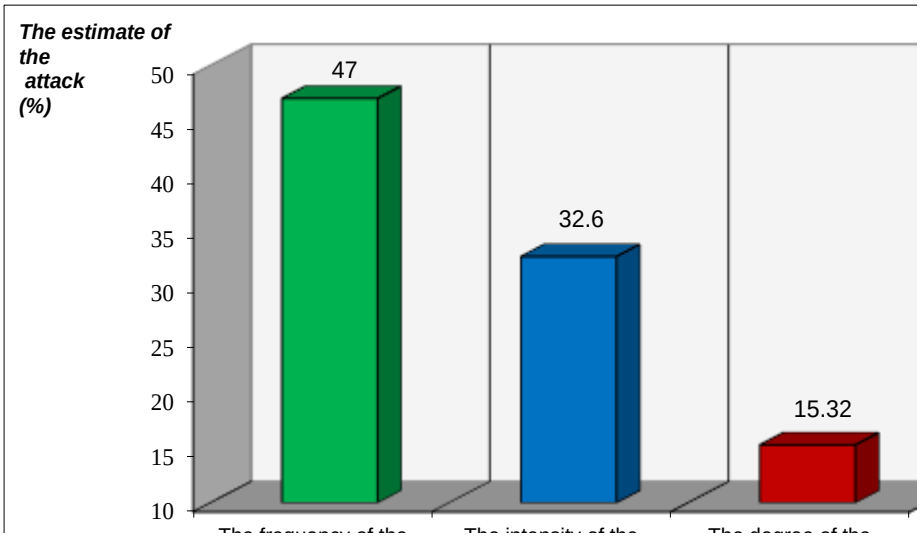


Fig. 3. The estimation of the attack produced by *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon in the *Malus domestica* Borkh.

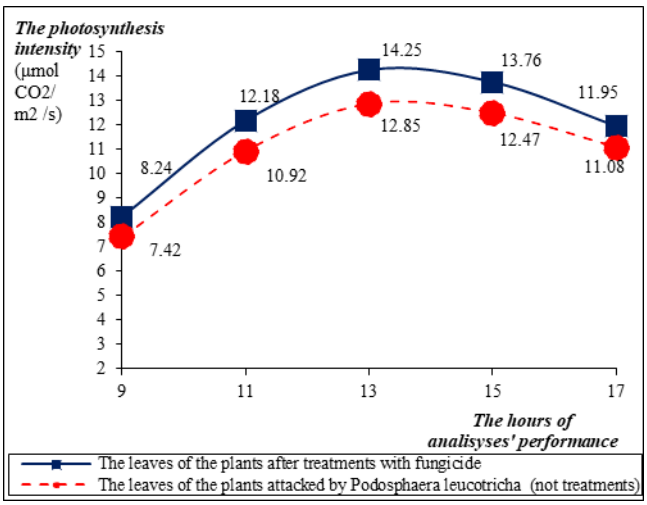


Fig. 4. The photosynthesis intensity in the leaves of the apple tree (*Malus domestica* Borkh.).

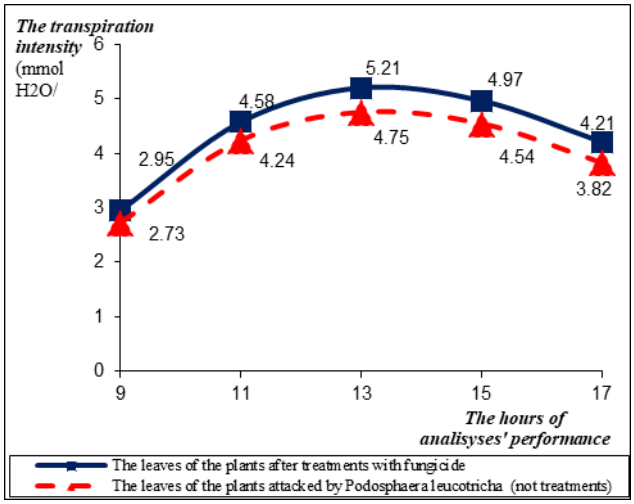


Fig. 5. The transpiration intensity in the leaves of the apple tree (*Malus domestica* Borkh.).

The physiological processes (photosynthesis and transpiration intensity) are correlate with the physiological parameters (the photosynthetic active radiation, the leaf temperature and the stomatal conductance), but it has different values on the leaves of the plants to which the fungicides were applied, compared to the leaves attacked by the pathogen.

The physiological researches carried out on the leaves of the plants show an increase of the physiological parameters, during the day, growth starting in the morning; it has higher values in the afternoon and a decrease in the evening (Table. 1).

The intensity of physiological processes (photosynthesis and transpiration intensity) depending on the light radiation received by leaves and the position of leaves on *Malus domestica* Borkh.

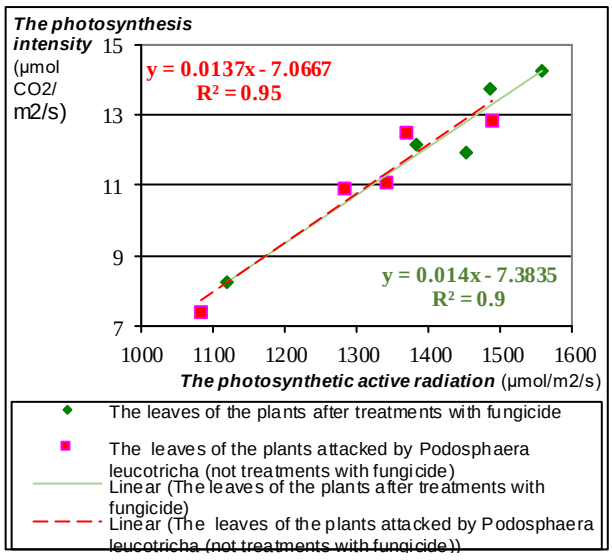
Linear regression performed between the photosynthesis intensity and photosynthetic active radiations show a positive correlation, the coefficient of determination (R^2) was 0.90 for the leaves of the plants after treatment with fungicide and 0.95 for the leaves of the plants attacked by pathogen - not treated with fungicide.

Table 1.The physiological parameters registered in the leaves of the apple tree

The physiological parameters	The leaves of the analyzed plants	The hours of the analyses' performance (July 10th 2018)				
		9^{00}	11^{00}	13^{00}	15^{00}	17^{00}
The photosynthetic active radiation *(µmol / m² / s)*	The leaves of the plants after treatments with fungicide	1120	1385	1558	1486	1452
	The leaves of the plants attacked by pathogen	1084	1285	1490	1370	1341
The leaf temperature *(°C)*	The leaves of the plants after treatments with fungicide	28.2	31.5	35.5	34.9	34.1
	The leaves of the plants attacked by pathogen	28.3	31.8	35.7	35.0	34.3
The stomatal conductance *(mol / m² / s)*	The leaves of the plants after treatments with fungicide	0.06	0.08	0.12	0.11	0.10
	The leaves of the plants attacked by pathogen	0.04	0.06	0.11	0.09	0.08

Linear regression performed between the transpiration intensity and photosynthetic active radiations show a positive correlation, the coefficient of determination R^2 was 0.86 for the leaves of the plants after treatment with fungicide and 0.90 for the leaves of the plants attacked by pathogen - not treated with fungicide (Fig. 6 and Fig. 7).

Linear regression performed between the transpiration intensity and leaf temperature show a good positive correlation, the coefficient of determination R^2 was 0.81 for the leaves of the plants after treatment with fungicide and 0.78 for the leaves of the plants attacked by pathogen - not treated with fungicide.



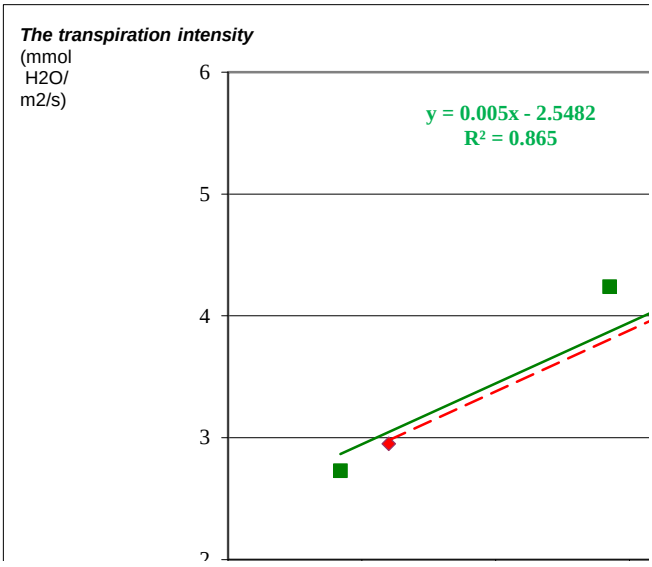
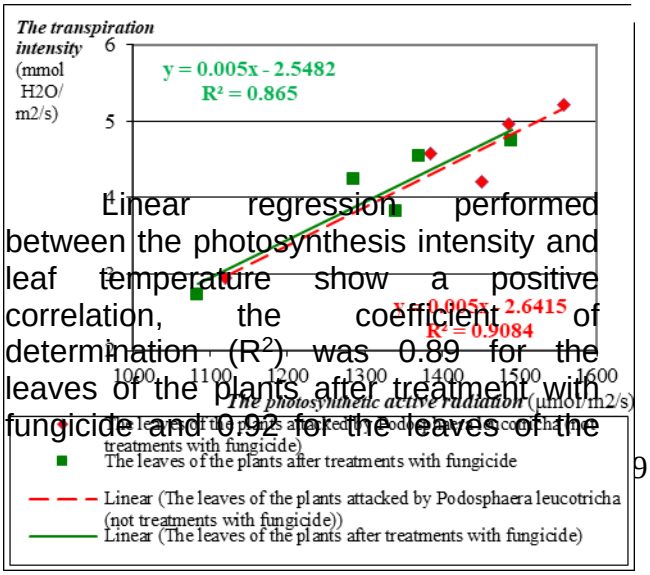


Fig. 7. The correlation between the intensity of transpiration and the photosynthetic active radiation in *Malus domestica* Borkh.

Linear regression performed between the photosynthesis intensity and leaf temperature show a positive correlation, the coefficient of determination (R^2) was 0.89 for the leaves of the plants after treatment with fungicide and 0.92 for the leaves of the plants attacked by pathogen - not treated with fungicide (Fig. 8 and Fig. 9).



Linear regression performed between the photosynthesis intensity and stomatal conductance show a positive correlation, the coefficient of determination (R^2) was 0.86 for the

leaves of the plants after treatment with fungicide and 0.85 for the leaves of the plants attacked by pathogen - not treated with fungicide. Linear regression performed between the transpiration intensity and stomatal conductance show a positive correlation, the coefficient of determination R^2 was 0.78 for the leaves of the plants after treatment with fungicide and 0.73 for the leaves of the plants attacked by pathogen - not treated with fungicide (Fig. 10 and Fig. 11).

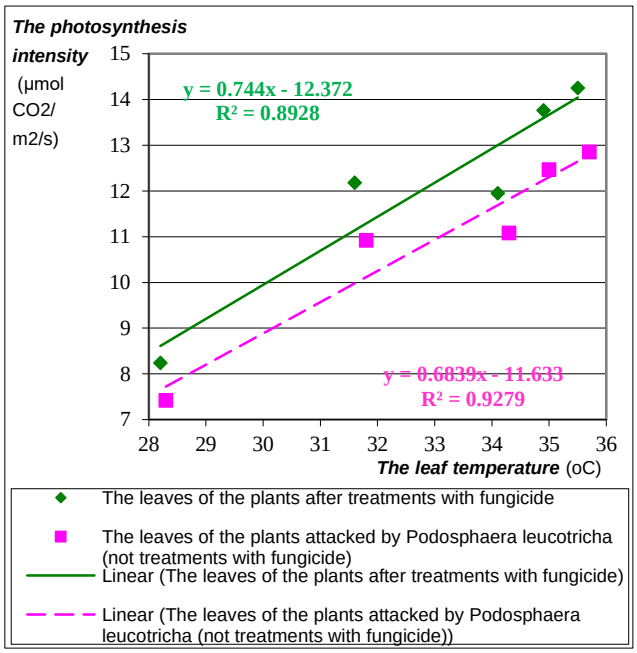


Fig. 8. The correlation between the intensity of photosynthesis and the leaf temperature in *Malus domestica* Borkh.

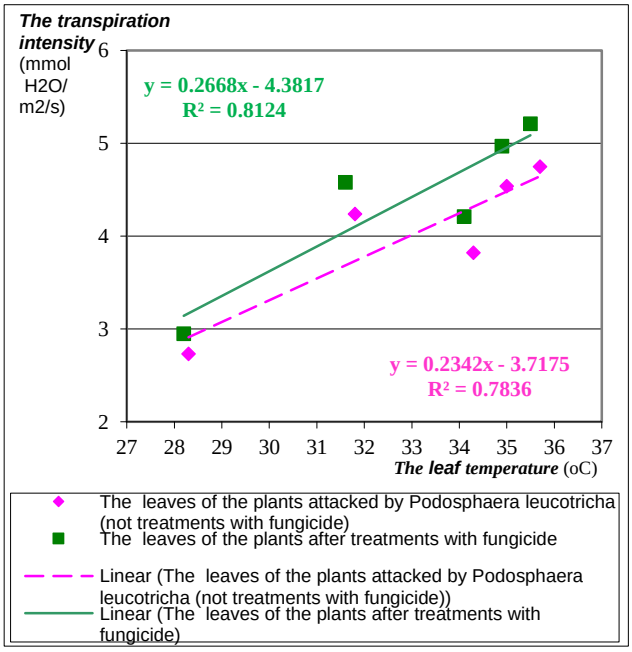


Fig. 9. The correlation between the intensity of transpiration and the leaf temperature in *Malus domestica* Borkh.

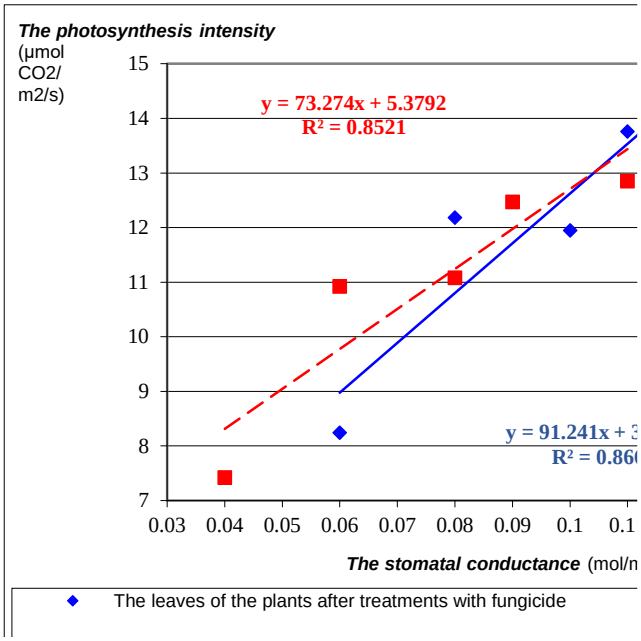


Fig. 10. The correlation between the intensity of photosynthesis and the stomatal conductance in *Malus domestica* Borkh.

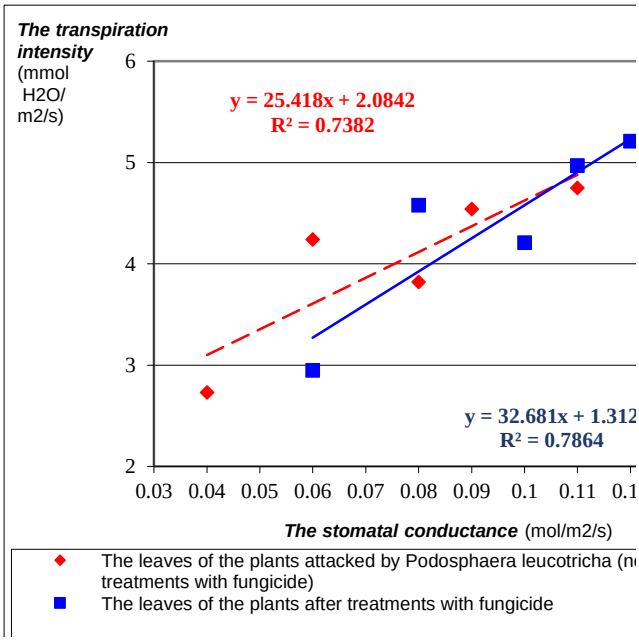


Fig. 11. The correlation between the intensity of transpiration and the stomatal conductance in *Malus domestica* Borkh.

The water content has a higher values and the dry substance content has a lower values in leaves of the plants after treatment with fungicide, compared with the leaves of the plants attacked by pathogen - not treated with fungicide (Fig. 12).

In the leaves plants analysed after performing treatments with fungicide has a higher chlorophyll content, compared with the leaves plants attacked by pathogen, fact that correlates with the intensity of photosynthesis (Fig. 13).

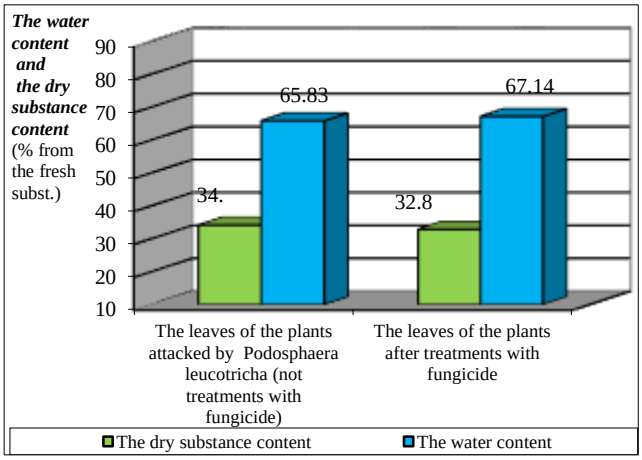


Fig. 12. The water content and the dry substance content in the leaves of *Malus domestica* Borkh.

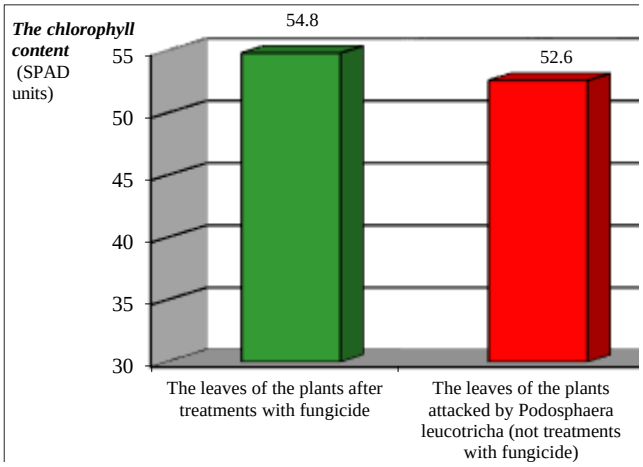


Fig. 13. The chlorophyll content in the leaves of *Malus domestica* Borkh.

CONCLUSIONS

In the *Malus domestica* Borkh. it was observed that the photosynthesis intensity and transpiration intensity vary during the day according to climatic conditions, presenting lower values in the morning, higher values in the afternoon and lower values at night, but the recorded values are higher for the already analysed leaves plant after performing fungicide treatments, in comparison with the leaves plant attacked by the pathogen - not treated with fungicide.

In the *Malus domestica* Borkh. was observed that photosynthesis intensity and transpiration intensity presents a minimum values in the morning, a maximum values after lunch and a minimum value toward the evening, but these processes have lower values in the leaves attacked by pathogen, compared with the leaves plant analized after treatments with fungicide.

The intensity of the photosynthesis and transpiration intensity is correlate with the photosynthetic active radiation, leaf temperature and stomatal conductance, but coefficient of determination (R^2) presents different values in the leaves of the apple tree in which treatments with fungicides have been performed, in comparison with the leaves attacked by the pathogen (not treated with fungicide), a strong association between these was established.

In the leaves of the apple tree it can be observed that between the clorophyll content and the photosynthesis intensity is a positive correlation.

In the leaves plant analysed after performing treatments with fungicide it was registered a higher water content and chlorophyll content, compared with the plant leaves attacked by *Podosphaera leucotricha* (Ellis & Everh.) E. S. Salmon where the decrease of turgescence and the deterioration of the chlorophyll has consequences on apple production.

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