

## RESEARCH REGARDING THE EFFECTS OF THE TREATMENT WITH FUNGICIDES ON THE PHYSIOLOGICAL PROCESSES IN *Lycopersicon esculentum* MILL. PLANTS ATTACKED BY *Phytophthora infestans* (MONT.) DE BARY

NICOLAE Ion, BUȘE-DRAGOMIR Luminița

**Abstract.** Physiological researches were performed at tomato plants grown in the region of Oltenia. After the reporting and identification of the attack produced by the pathogen, tomato culture has been divided into two groups, a first group where fungicide treatment was applied and the second group without treatments. After applying the treatments, physiological analysis were carried out on July 14<sup>th</sup> 2012, at the attacked plants (plants without treatment), compared to the plants treated with fungicides (plants with treatment). It was found that the intensity of photosynthesis and transpiration intensity vary according to the analysed plants and climatic conditions. In the attacked plants by the pathogen there was registered a lower intensity of photosynthesis, which is correlated with the low chlorophyll content, but also a decreased intensity of transpiration due to the deterioration of leaves and stomata coverage by the mycelium pathogen. It was also recorded a lower water content and a higher content of dry matter, which caused serious hydric and metabolic imbalances in the attacked plants, compared to the plants where fungicide treatments were applied.

**Keywords:** fungicide, pathogen, physiological processes, tomato plants.

**Rezumat.** Cercetări privind efectele tratamentului cu fungicide asupra proceselor fiziologice la plantele *Lycopersicon esculentum* Mill. atacate de *Phytophthora infestans* (Mont.) de Bary. Cercetările fiziologice s-au efectuat la plantele de tomate cultivate în zona Olteniei. După semnalarea și identificarea atacului produs de patogen, cultura de tomate a fost împărțită în două loturi, la un lot s-au efectuat tratamente cu fungicide, iar la al doilea lot nu s-a efectuat tratamente. După aplicarea tratamentelor s-au efectuat analize fiziologice, la data de 14 iulie 2012, la plantele atacate de patogen (plante fără tratament), în comparație cu plantele tratate cu fungicide (plante cu tratament). S-a constatat că intensitatea fotosintezei și intensitatea transpirației variază în funcție de plantele analizate și condițiile climatice. În plantele atacate de patogen s-a constatat scăderea intensității fotosintezei, fapt corelat cu conținutul scăzut în clorofilă, dar și scăderea intensității transpirației ca urmare a deteriorării frunzelor și acoperirii stomatelor de către miceliu patogenului. S-a înregistrat, de asemenea un conținut mai scăzut de apă și un conținut mai mare de substanță uscată, fapt ce a determinat grave dezechilibre hidrice și metabolice în plantele atacate, comparativ cu plantele la care s-au efectuat tratamente cu fungicide.

**Cuvinte cheie:** fungicid, patogen, procese fiziologice, plante de tomate.

### INTRODUCTION

The physiological research has been carried out after applying treatments with fungicides and consisted in carrying out analysis of the attacked plants, compared to the treated plants with fungicide.

Vegetables are plants known for their nutritional value and therapeutic effects. Vegetable consumption stimulates body hydration, muscle activity, appetite, calcification, enzyme activity, defense ability, inhibits bacterial fermentation, and provides essential amino acids (SUCIU et al., 1987).

*Lycopersicon esculentum* Mill. (syn. *Solanum lycopersicum* L.) is a herbaceous plant, vegetable, with therapeutic value. Tomatoes have a differentiated tissues structure with different chemical composition and physiological activity (HOROTAN & OANCEA, 2013).

*Phytophthora infestans* (Mont.) de Bary is an important and destructive disease on tomatoes. Crop losses are very high, the percentage of fruits damaged exceeding 50% in untreated cultures.

In the last decades, the use of fungicides in agriculture for fungi diseases control has become crucial. Fungicide research has produced a diverse range of products with new modes of action. However, the extensive use of these compounds in the agriculture system raises public concern because of the harmful potential of such substances in the environment and human health (DIAS, 2012).

Application of fungicides may affect crop physiology by various disruptions such as growth reduction, perturbation in the development of reproductive organs, alteration of nitrogen, and/or carbon metabolism leading to a lower nutrient availability for plant growth. This former physiological trait is fundamental for plant culture and is reflected by both photosynthetic rate and mobilization of carbohydrate reserves (PETIT et al., 2012).

The diurnal dynamics of photosynthesis and transpiration in the attacked leaves plants is similar to that in the plant leaves analysed after treatments, but the recorded values are lower in the attacked leaves (NICOLAE & BUȘE-DRAGOMIR, 2013).

The intensity of photosynthesis processes in normal conditions tomato plant growth is 12.9  $\mu\text{mol}/\text{m}^2/\text{s}$  (GALTIER et. al., 1995). Determinations carried out in tomato plant show that the intensity of photosynthesis processes at basal leaves is lower (3.35  $\mu\text{mol}/\text{m}^2/\text{s}$ ); the intensity of this process increases at leaves of the middle plant (10.73  $\mu\text{mol}/\text{m}^2/\text{s}$ ) and falls to the top of the plant leaves (5.19  $\mu\text{mol}/\text{m}^2/\text{s}$ ) - BURZO et. al., 2000.

Positive correlations were established between the intensity of the physiological processes and the photosynthetic active radiation, the leaf temperature and stomatal conductance of  $\text{CO}_2$  (NICOLAE, 2010).

## MATERIAL AND METHODS

Physiological research on the effects of the treatment with fungicides on the intensity of the physiological processes was performed in tomato plants (*Buzău 50* variety) cultivated in the region of Oltenia (Dolj county).

*Buzău 50* variety is an early variety, with an indefinite increase. Plants are vigorous (190 cm) and have rich foliage that protects fruit. The fruits are spherical, have intense red color and have an average weight of 250 g.

After reporting the attack and identification of natural attack produced by *Phytophthora infestans* (Mont.) de Bary, at the beginning of formation of fruits, the tomato crops were divided into two groups (the experimental variants). In case of the first group of plants, there have been conducted three treatments with fungicide *Shavit F 72 WP* at a period of 7 days between treatments (plants with treatment), while in case of the second group, there has been applied no treatment (untreated control plants). After a period of 10 days from the last treatment plants were analysed physiologically. The analyses were performed on the 14<sup>th</sup> of July 2012 at the attacked plants, compared to the treated plants with fungicide.

*Shavit F 72 WP* (Triadimenol 20 g/kg + Folpet 700 g/kg), produced by Makhteshim Agan-Israel, is a complex fungicide containing two active substances with systemic and contact action, which ensures a quick effect, preventative and curative of long duration.

The protection period depends on the local conditions and varies from 7 to 14 days. In case of the tomato plants attacked by the pathogen, the dose applied was 0.2% (20 g per 10 liters of water).

The physiological processes intensity was established with the photosynthesis measurement system LCI (Ultra Compact Photosynthesis System - ADC BioScientific Ltd.) and the obtained results were graphically represented and statistically interpreted using the Excel software.

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

The chlorophyll content was estimated by Minolta SPAD 502. The estimate of the attack produced by pathogen was made using the calculation formulae elaborated by SĂVESCU & RAFAILĂ, 1978.

## RESULTS AND DISCUSSIONS

Late blight caused by *Phytophthora infestans* (Mont.) de Bary is manifested by the appearance of some large spots, grey-green, with downy whitish on the underside of the leaf, on the edge and especially on the tips of the leaves. The attacked tissues get brown and the edges of the leaves get dry and twist towards the top. On the stems and petiole of the leaf, there appear elongated, discoloured spots, which become brown or grey-brown (Fig. 1).

The most common and damaging form of the attack is the one on the fruits. The attack starts with the formation of the fruit and lasts until ripening. Around the fruit peduncle, large, yellowish-green spots form, which then become grey-brown with uneven well, hard and dry surface. The brown spots expand then into the pulp of the fruit (MITREA, 2006).

*Phytophthora infestans* (Mont.) de Bary presents hyaline sporangiophores, non-septate, fasciculate, monopodial branching; they go out by the ostiole of stomata presenting a terminal unicellular, hyaline, limoniforme sporanges (TĂNASE & ȘESAN, 2006) - Fig. 2.



Figure 1. The *Lycopersicon esculentum* attacked by *Phytophthora infestans* (original).



Figure 2. *Phytophthora infestans* - sporangiophores with sporanges (oc. 10 x ob. 20) (original).

The evolution of temperatures and rainfall during the vegetation period favoured the emergence of the disease. Through the application of the foliar surface treatment with fungicides necrosis was significantly reduced, and the leaves with specific symptoms of the attack produced by the pathogen have maintained green during the vegetation period.

The physiological research was performed on the 14<sup>th</sup> of July 2012, at the plants attacked by *Phytophthora infestans* (Mont.) de Bary (plants without treatment), compared to the plants that have received fungicide treatments (plants with treatment).

The estimation of the attack (frequency, intensity and degree of attack) produced by the pathogen at the attacked plants is presented in Fig. 3.

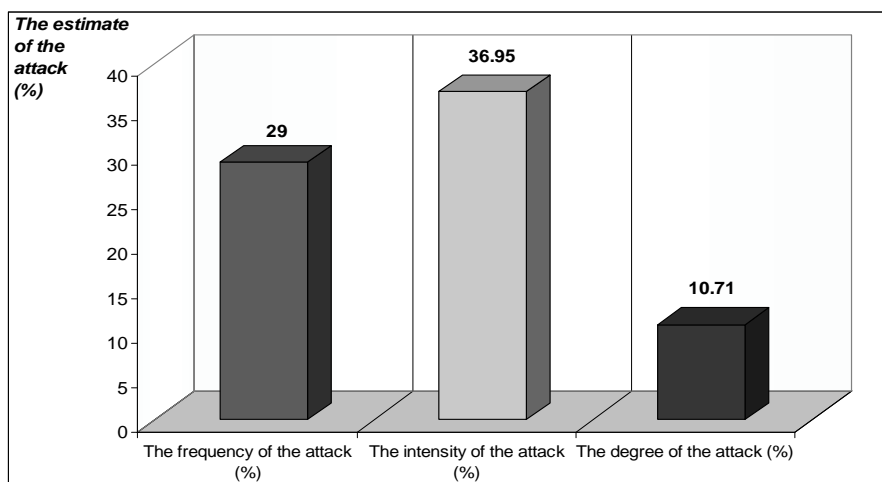


Figure 3. The estimate of the attack produced by *Phytophthora infestans* (Mont.) de Bary in *Lycopersicon esculentum* Mill.

Physiological processes intensity is lower in the tomato plants attacked by the pathogen, compared to the plants analysed after the treatment with fungicides, as a result of the reduction of the assimilation surface due to the reaction of the plants to the pathogen, deterioration of the chlorophyll pigments and stomata coverage by the pathogen (Figs. 4; 5).

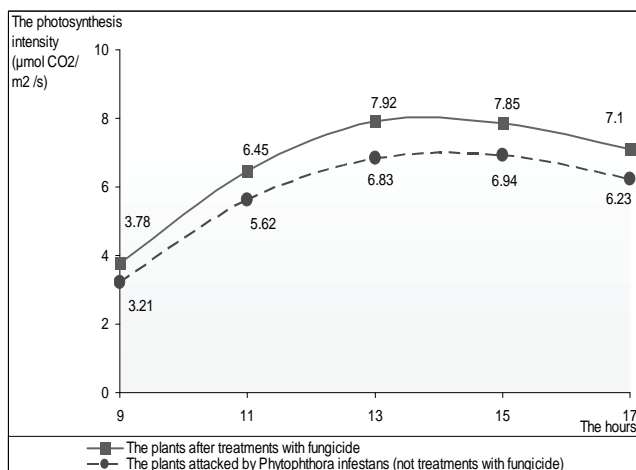


Figure 4. Diurnal dynamics of the photosynthesis intensity in tomato plants (*Lycopersicon esculentum* Mill.).

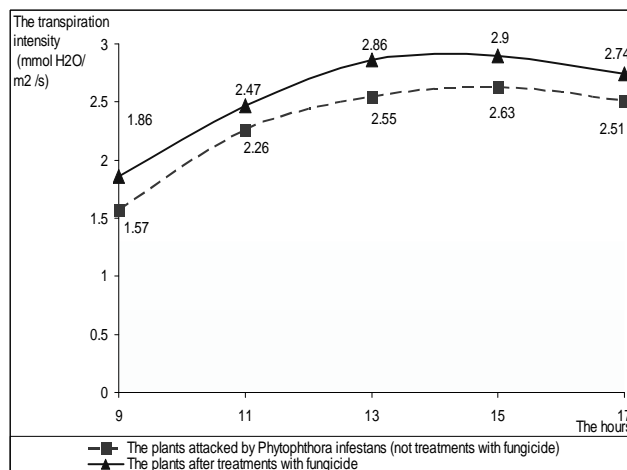


Figure 5. Diurnal dynamics of the transpiration intensity in tomato plants (*Lycopersicon esculentum* Mill.).

The physiological processes intensity (photosynthesis and transpiration intensity) is correlate with the physiological parameters (photosynthetic active radiation present on the surface of the leaves, leaf temperature, stomatal conductance of CO<sub>2</sub>), but presents different values in the tomato plants attacked by *Phytophthora infestans* (Mont.) de Bary, in comparison with the tomato plants analysed after the treatments with fungicide. Thus, there was established a strong association between these.

As a result of the physiological research carried out at the tomato plants one can observe an increase of the physiological parameters, during the day, increase starting in the morning; they present higher values at lunch and a gradually decrease towards evening (Table 1).

Table 1. Diurnal dynamics of the physiological parameters registered in tomato plants.

The physiological parameters in the tomato plants		The hours of performed analyses				
		9 <sup>00</sup>	11 <sup>00</sup>	13 <sup>00</sup>	15 <sup>00</sup>	17 <sup>00</sup>
The photosynthetic active radiation ( $\mu\text{mol} / \text{m}^2 / \text{s}$ )	The plants after the treatments with fungicide	1150	1485	1645	1565	1490
	The plants attacked by the pathogen	1135	1470	1634	1548	1475
The leaf temperature ( $^{\circ}\text{C}$ )	The plants after the treatments with fungicide	28.3	31.4	34.1	33.2	33.1
	The plants attacked by the pathogen	28.4	31.4	34.3	33.5	33.3
The stomatal conductance ( $\text{mol} / \text{m}^2 / \text{s}$ )	The plants after the treatments with fungicide	0.06	0.08	0.13	0.12	0.1
	The plants attacked by the pathogen	0.04	0.07	0.1	0.09	0.07

Linear regression carried out between the photosynthesis intensity and photosynthetic active radiations present on the surface of the leaves shows a good positive correlation between these; the coefficient of determination ( $R^2$ ) is 0.87 for the tomato plants attacked by the pathogen and 0.96 for the tomato plants after the treatments with fungicide. Linear regression carried out between the transpiration intensity and photosynthetic active radiations shows a good positive correlation; the coefficient of determination ( $R^2$ ) is 0.90 for the attacked tomato plants and 0.92 for the tomato plants after the treatments with fungicide (Figs. 6; 7).

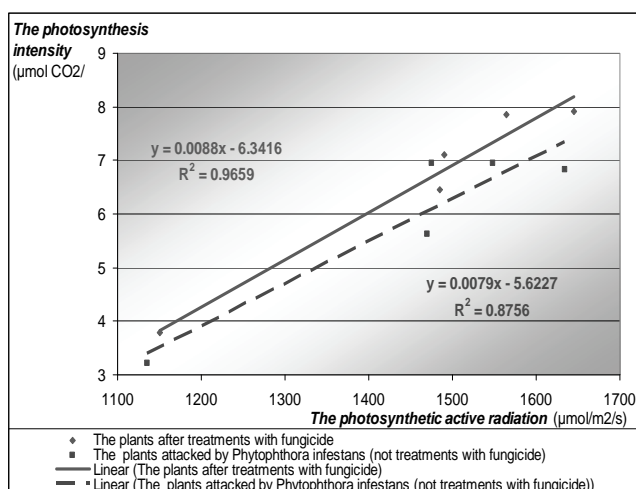


Figure 6. The correlation between the photosynthesis intensity and the photosynthetic active radiation in tomato plants (*Lycopersicon esculentum* Mill.).

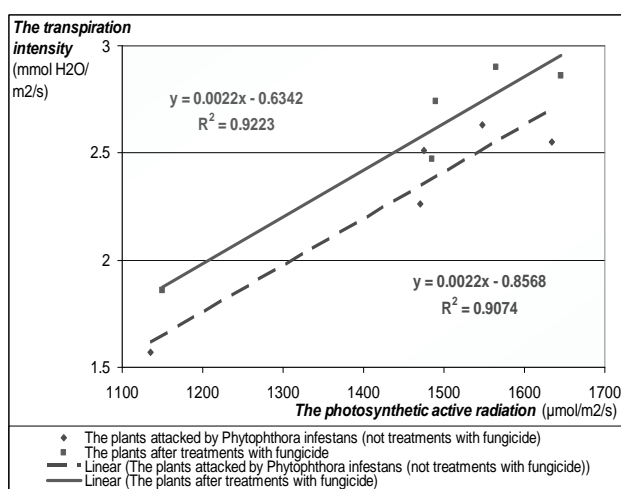


Figure 7. The correlation between the transpiration intensity and the photosynthetic active radiation in tomato plants (*Lycopersicon esculentum* Mill.).

Linear regression carried out between the photosynthesis intensity and leaf temperature shows a good positive correlation; the coefficient of determination ( $R^2$ ) is 0.95 for the attacked tomato plants and 0.96 for the tomato plants after the treatments with fungicide. Linear regression carried out between the transpiration intensity and leaf temperature shows a good positive correlation between these; the coefficient of determination ( $R^2$ ) is 0.94 for the attacked tomato plants and 0.96 for the tomato plants after the treatments with fungicide (Figs. 8; 9).

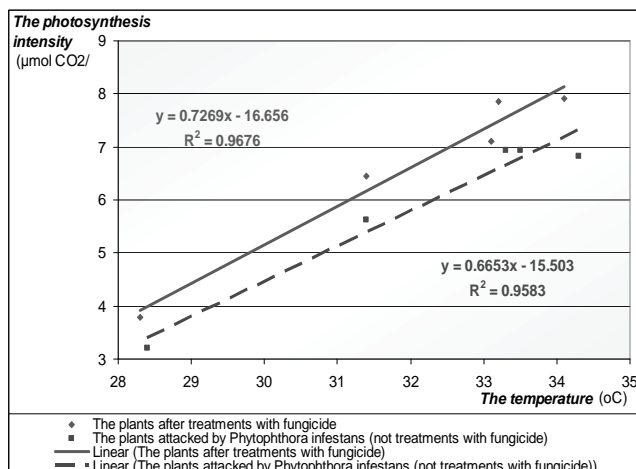


Figure 8. The correlation between the photosynthesis intensity and the leaf temperature in tomato plants (*Lycopersicon esculentum* Mill.).

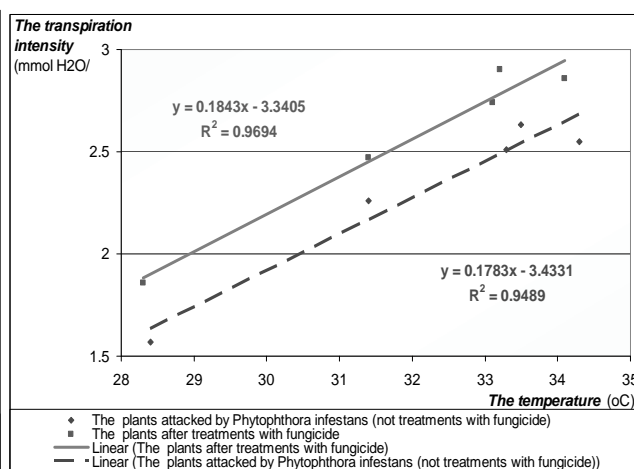


Figure 9. The correlation between the transpiration intensity and the leaf temperature in tomato plants (*Lycopersicon esculentum* Mill.).

Linear regression performed between the photosynthesis intensity and stomatal conductance of CO<sub>2</sub> shows a positive correlation between these; the coefficient of determination (R<sup>2</sup>) is 0.76 for the attacked tomato plants and 0.86 for the tomato plants after the treatments with fungicide. Linear regression made between the transpiration intensity and stomatal conductance of CO<sub>2</sub> shows a positive correlation; the coefficient of determination (R<sup>2</sup>) is 0.81 for the attacked tomato plants and 0.86 for the tomato plants after treatments with fungicide (Figs. 10; 11).

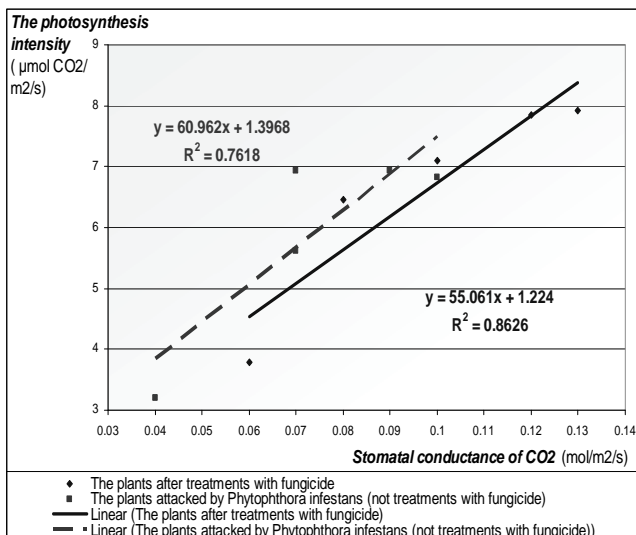


Figure 10. The correlation between the photosynthesis intensity and the stomatal conductance in tomato plants (*Lycopersicon esculentum* Mill.).

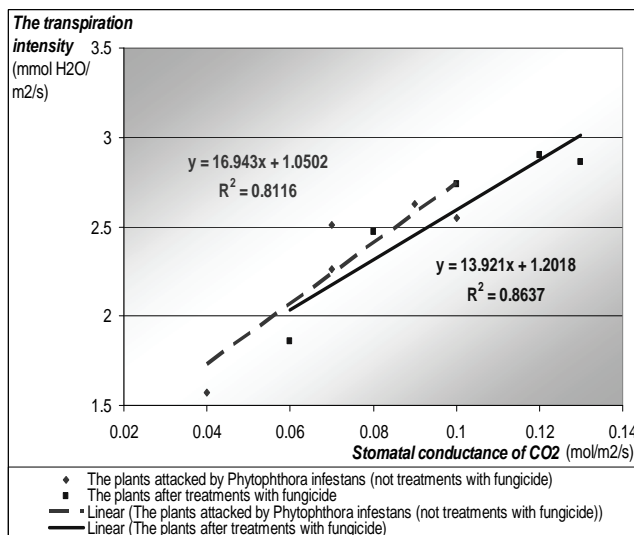


Figure 11. The correlation between the transpiration intensity and the stomatal conductance in tomato plants (*Lycopersicon esculentum* Mill.).

The tomato plants attacked by the pathogen present a 3.02 % lower water content and a 14.97 % higher dry substance content in comparison with the tomato plants after the treatments with fungicide (Fig. 12).

In the attacked tomato plants, it is noticed a 17.88 % lower chlorophyll content as a result of the deterioration of the chlorophyllian pigments under the action the pathogen (Fig. 13).

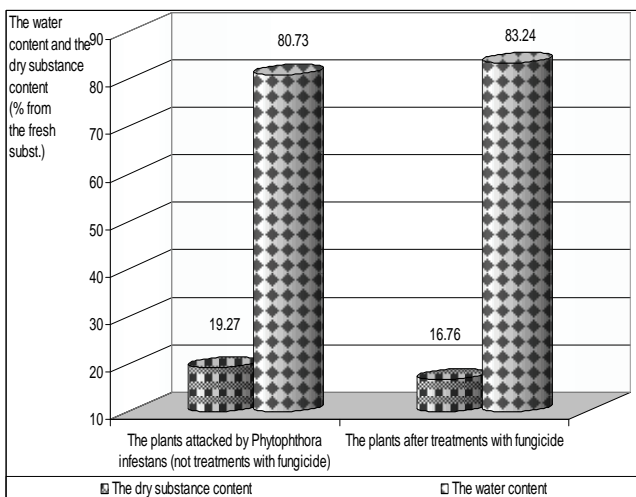


Figure 12. The water content and the dry substance content in the leaves of tomato plants (*Lycopersicon esculentum* Mill.).

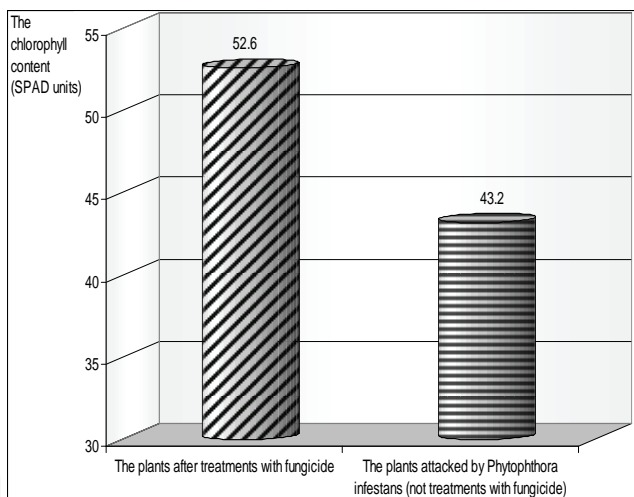


Figure 13. The chlorophyll content in the leaves of tomato plants (*Lycopersicon esculentum* Mill.).

### CONCLUSIONS

After the application of the treatments with fungicides in the tomato plants attacked by *Phytophthora infestans* (Mont.) de Bary it has been noticed the significantly reduced degree of diseases, the reduction of the area affected by the pathogen; the applied treatments have also influenced the plant growth and the further development of the plants.

In tomato plants it has been noticed that the dynamics of photosynthesis and transpiration, during the day, in the plants attacked by the pathogen is similar to that in plant analysed after the treatments with fungicide, but the recorded values are lower in the attacked plants.

At the plants attacked by the pathogen, it was noticed that photosynthesis and transpiration intensity is lower as a result of the reduction of the leaf surface due to the formation of large, grey-green or brown spots, deterioration of the chlorophyll pigments and stomata coverage by the pathogen.

The attacked tomato plants present a lower chlorophyll content and a lower water content, in comparison with the tomato plants analysed after the treatments with fungicide, which caused hydric and metabolic imbalances.

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##### Ion Nicolae

Faculty of Agriculture and Horticulture, University of Craiova  
13, A. I. Cuza Street, 200585, Craiova, Romania.  
E-mail: ionnicolaebio@yahoo.com

##### Luminița Bușe-Dragomir

Faculty of Agriculture and Horticulture, University of Craiova  
13, A. I. Cuza Street, 200585, Craiova, Romania.  
E-mail: luminita25dragomir@yahoo.com

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