ANALIZATION OF PHOTOSYNTHETIC ACTIVITY AND TRANSPIRATION ACTIVITY IN PEAR TREES DEPENDING ON THE ACTION OF BIOLOGICAL ACTIVE SUBSTANCES

ANALIZA ACTIVITĂŢII FOTOSINTETICE ŞI TRANSPIRAŢIEI LA POMII DE PĂR ÎN DEPENDENŢĂ DE ACŢIUNEA SUBSTANŢELOR BIOLOGIC ACTIVE

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Abstract: *Research to elucidate the effectiveness of photosynthesis and transpiration intensity in depending on the donor – acceptor process in pear plants has been carried out. The obtained results have shown that the physiological state of the plants during the active of the vegetation period can be characterized depending on the season and the specificity of the vegetation period performance in dynamic of the photosynthesis efficacy and transpiration activity . It has been established that in the spring, during the vegetation period, the pear trees with the increase of the intensity of the photosynthesis and transpiration activity.*
Key words: Photosynthesis, transpiration, donor – acceptor, pear tree, *Verbascozida*, LCi – 4 Portable Photosynthesis System

Rezumat: *Cercetările efectuate vizează elucidarea eficacităţii fotosintezei şi transpiraţiei în dependenţă de donor - acceptor în plantele de pere. Rezultatele obţinute au demonstrat, că starea fiziologică a plantelor în perioada activă de vegetaţie poate fi caracterizată în funcţie de sezon şi specificitatea perioadei de vegetaţie în dinamica eficacităţii fotosintezei. A fost stabilit, că primăvara, în perioada de vegetaţie,la pomii de păr creşte intensitatea fotosintezei.*
Cuvinte cheie: Fotosinteza, transpiraţia, donor – acceptor, părul, *Verbascozida*, LCi – 4 - sistem portabil de fotosinteză

INTRODUCTION

It is known that photosynthetic activity and transpiration intensity in the pear orchard depends on a complex of internal and external factors, which manifest in dynamics on the date of measurements. The intensity of photosynthesis and transpiration is the basic indicator that characterizes the functionality of the photosynthetic apparatus, which is widely used in the scientific and practical physiological investigations. The purpose of the investigations is to evaluate in dynamics the productive potential of the plantation for the production of pear trees, by the capacity of assimilation of the

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photosynthetic apparatus and transpiration in response to the action of the biologically active substances.

MATERIAL AND METHOD

The scientific researchers were carried out in the pear orchard of the company "Delectar", Onesti com., Hânceşti district. The control pear trees were sprayed with water and the aqueous solution of the Verbascozida natural growth regulator at a concentration of 0.01%. The study investigates the two varieties of late pears Noyabrskaya variety and Vystavochnaya variety. Two weeks later, in dynamics, during the vegetation period, photosynthetic intensity and other 11 parameters (indicated below) were determined in the leaves of the pear trees directly in the orchard, for the first time by using the LCi - 4 Portable Photosynthesis System, presented at the International Conference of Plant Physiology in Poland and donated to the Republic of Moldova by the World Bank for the purpose of linking physiological researches to international standards.

RESULTS AND DISCUSSIONS

The LCi – 4 (BCI., 1994) device (fig.1) consists of a contact chamber connected to pear leaves, a block composed of two specialized computers: 1 - measures the required parameters, 2 - analyzes the data obtained, which displays them on the screen and accumulates them in memory, where can be removed to a memory card.

$$\mathbf{6CO_2}(\text{Can;Cj;}\Delta\text{C;V})+\mathbf{6H_2O}(\text{Ean;}\Delta\text{E})+\mathbf{Q}(\text{P.A.R;T-chamber/leaves})=\mathbf{C_6H_{12}O_2}+\mathbf{6O_2}$$

Analyzing the above photosynthesis formula (Rabinovich E. 1953., p.287) and fig.1 we note that of the 12 parameters (shown below) by measurements with LCi – 4 Portable Photosynthesis System: 4 parameters refer to CO2 determination; 2 parameters refer to the determination of H2O; 3 - Photosynthetic active radiation, and T – temperature in the measurable room and of the leaf.

Fig. 1 LCi – 4 Portable Photosynthesis System

1. V - CO_2 flow (reference), VPM
2 , 3. T, ^0C – in the measurable room / of the leaf
4. The intensity of photosynthesis, µmol m^{-2} s^{-1}
5. The intensity of transpiration, mmol m^{-2} s^{-1}
6. Conductivity of the stomatas at CO_2, mol m^{-2} s^{-1}
7. Photosynthetic active radiation, µmol m^{-2} s^{-1}
8. Can - CO_2 from exterior, h=3m from the soil, VPM
9. Cj - CO_2 in the measurable room, VPM
10. ΔC (=Cref - Can), VPM
11. Ean –saturation of the air with humidity, mbar
12. ΔE-partial pressure, mbar

Fig. 2 Noyabrskaya variety

Fig. 3 Vystavochnaya variety

Noyabrskaya variety, short description

Noyabrskaya variety (Дushutina, 1979), short description: this pear (*Pyrus*), family *Rozaceae* variety (fig.2) originates from the Republic of Moldova. Winter variety. Standard variety, premium class. Author is Xenia Duşutina. Noyabrskaya is a hybrid of the varieties Nicolai Kriuger x Triumph of Vienna. Spread under the name Xenia. Variety is popular in Europe due to the superior quality of the fruits (a ball of 4, 6 out of 5 possible) and their long-lasting, widely used in the fruit processing industry.

This variety is one of the most resistant to frost, diseases, etc.

It is the most cultivated variety of pears in the Republic of Moldova due to the very large size of fruits, which can reach up to 600 g/one.

When harvesting, the fruits are green and stony, but after several weeks of storage they soften and turn yellow and flavored, with a unique taste.

The harvest is done in October and full maturity reaches in November, hence the name of this particular variety. Under optimal conditions it can be kept until April.

Vystavochnaya variety, short description

This pear (*Pyrus*), family *Rozaceae* Vystavochnaya variety (Дushutina, 1979), (fig. 3) originates from the Republic of Moldova. Autumn variety. Standard variety, premium class. Author is Xenia Duşutina. Vystavochnaya is a hybrid of the varieties Triumph of Vienna x Olyvie de Serr, resistant to winter conditions, fertile. The trees have average growth, born regularly. They are resistant to mane and staining of the leaves. The fruits are large, reaching the weight of 240-350g, are picked at the beginning of October, good taste (ball of 3.8 - 4.0 out of 5 possible), are used for consumption in November-January, under refrigerator storage conditions-in January-February.

Results on the mathematical analysis photosynthetic activity with graphical presentation of the results, Noyabrskaya variety and Vystavochnaya variety.

Each measurement includes three rehearsals-mandatory conditions.

Significant - it results that SBA Verbascozida 0.01% has a higher effect compared to the control.

Table1

Average data for mathematical analysis, Noyabrskaya variety

Factors	Date of observation					
	30.05. 16	16.06. 16	07.07. 16	21.07. 16	12.08. 16	08.09. 16
Control	4.27±0.6	6.88±0.48	3.32±0.27	5.10±0.65	5.04±0.05	2.46±0.3
Verbascozida 0,01%	4.41±0.09	16.07±1.89	3.13±0.02	11.64±0.33	6.66±0.13	2.78±0.28

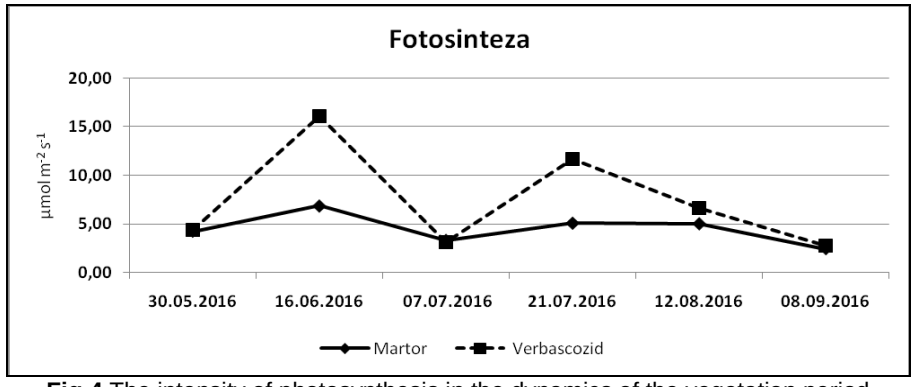

Fig.4 The intensity of photosynthesis in the dynamics of the vegetation period

Table 2

Average data for mathematical analysis, Vystavochnaya variety

Factors	Date of observation					
	30.05. 16	16.06. 16	07.07. 16	21.07. 16	12.08. 16	08.09. 16
Control	4.22±0.29	3.30±0.11	2.98±0.22	1.61±0.25	4.29±0.44	2.91±0.20
Verbascozida 0.01%	6.81±0.14	6.07±0.47	3.93±0.03	5.44±0.13	5.84±0.18	2.86±0.25

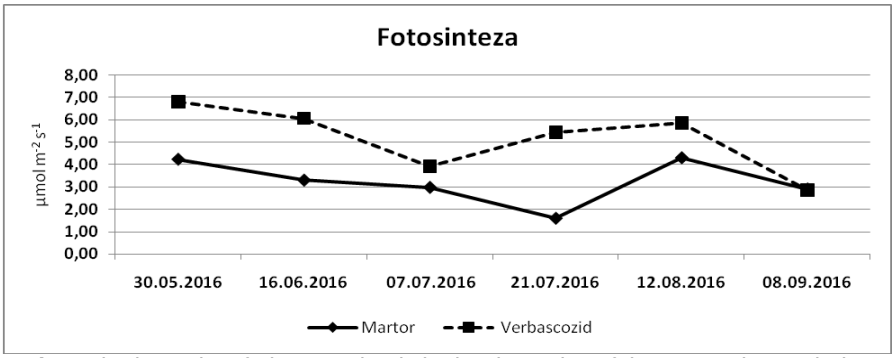

Fig.5 The intensity of photosynthesis in the dynamics of the vegetation period

The Photosyntesis intensity (µmol m^{-2} s^{-1}) represents the quantity of CO_2 used by an foliar surface, in an unity of time.

The results obtained on both varieties of pears show ensures of the formation of more assimilation centers (donor) in the apical tissues of the pear trees that allow the use (acceptor) of photosynthetic assimilations at the beginning of the intensive growth of shoots, as well of the growth of foliage and fruits (16.06.2016). At the same time, the data obtained demonstrates that the photosynthetic apparatus in the application of SBA *Verbascozida* 0.01% has a significantly higher capacity to insure the needs of pear plants compared to the control (tab.1.2, fig. 4, 5). Similar results by the Klimov S.V. 2008, p.128.

At the end of the vegetation period, when the effectiveness of the photosynthetic active centers diminishes (from 21 July to 08 September 2016), less characteristic for the 07.07.2016 period (because of the sudden cooling of the air and the heavy rains), the ability to synthesize the assimilation becomes equal to their of use and storage by the acceptance centers (donor), which results in the equilibrium of both the control and *Verbascozida* 0.01% variant, the latter being eliminated from the plant (fig.4, 5). Similar results were obtained by the authors (Rubin, 1970, Rabinovich, 1953).

The presence of photosynthesis of the foliage apparatus of the trees during the harvesting period contributes to an increase in the possibilities for preserving fruits.

Results on the mathematical analysis the intensity of transpiration with graphical presentation of the results, Noyabrskaya variety and Vystavochnaia variety.

Each measurement includes three rehearsals-mandatory conditions.

Table 3

Average data for mathematical analysis, Noyabrskaya variety

Factors	Observation data					
	30.05.2016	16.06.2016	07.07.2016	21.07.2016	12.08.2016	08.09.2016
Control	5.35±0.01	1.11±0.01	1.62±0.02	0.54±0.08	0.93±0.01	0.70±0.02
Verbascozida	5.92±0.04	0.74±0.01	1.57±0.20	2.32±0.02	0.75±0.00	1.56±0.02

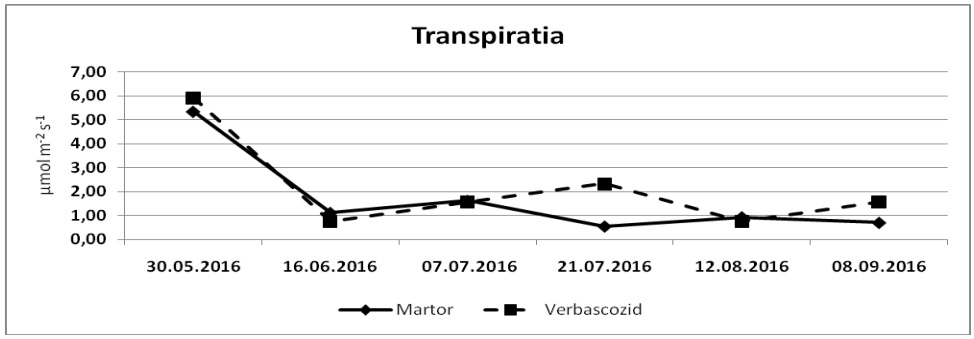

Fig.6 The transpiration in the dynamics of the vegetation period

Table4

Average data for mathematical analysis, Vystavochnaya variety

Factors	Observation Data					
	30.05.2016	16.06.2016	07.07.2016	21.07.2016	12.08.2016	08.09.2016
Control	2.45±0.18	1.31±0.02	1.70±0.08	0.44±0.14	1.29±0.01	0.83±0.03
Verbascozida	4.43±0.11	0.92±0.09	1.32±0.10	0.60±0.03	1.08±0.02	0.87±0.02

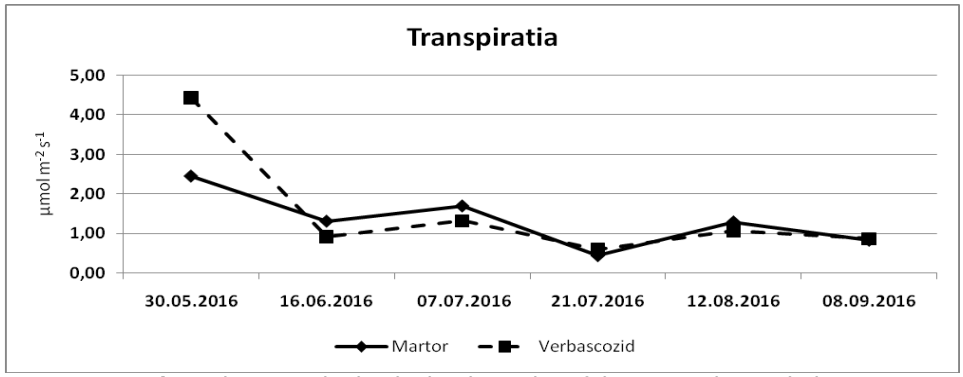

Fig.7 The transpiration in the dynamics of the vegetation period

Transpiration intensity (µmol m^{-2} s^{-1}) represents the quantity of water, which is evaporated by the plant in a period of time, in a leaf surface unite.

Results presented by Noyabrskaya variety in the third and forth measurements (tab.3, fig.6), and Vystavochnaya variety only in the third measurement (tab.4, fig.4)

present semnificative results, the rest of results being non-semnificative, because there is no separation between them, the results presented in (tab.4, fig. 7).

Table 5

As an example with the results of the second measurement from 16 th July 2016

Indices	Measurement units	From… to…	Noybriskayia		Vystavochnaya	
			Martor	verb.	Martor	Verb.
			08:50	09:50	09:55	10:15
V – CO_2 flow (reference)	VPM	0-2000	380	373	384	382
T, ^{0}C – in the measurable room	^{0}C	-5…+50	23.4	28.08	28.9	33.59
The intensity of photosynthes.	µmol m^{-2} s^{-1}	0-100	7.80	14.49	3.49	7.00
			6.63	19.83	3.30	5.50
			6.21	13.89	3.11	5.70
		media	*6.88*	*16.07*	*3.30*	*6.07*
The intensity of transpiration	mmol m^{-2} s^{-1}	0-50	1.1	0.74	1.35	1.04
			1.12	0.72	1.29	0.99
			1.12	0.76	1.30	0.74
		media	*1.12*	*0.74*	*1.31*	*0.92*
Conductivity of the stomatas at CO_2	Mol m^{-2} s^{-1}	0-100	0.02	0.03	0.04	0.17
			0.04	0.04	0.03	0.16
			0.03	0.04	0.04	0.17
		media	*0.03*	*0.04*	*0.04*	*0.17*
Photosynthetic active radiation	µmol m^{-2} s^{-1}	0-3000	1090	1049	1367	1286
T, ^{0}C – of the leaf	°C	-5+50	31.56	28.08	36.21	35.07
Can – CO2 outside, h=3m from the soil	VPM	0-2000	405.5	470.6	405.6	396.6
ΔC (=Cref-Can)	VPM	+/-2000	20.1	9.2	8.2	26.6
Cj – CO2 inside the room	VPM	0-2000	214.5	182.3	122.7	189.4
Ean – air saturation with humidity	Mbar	0-75	15.4	13.4	13.4	12.8
ΔE- partial pressure	Mbar	+/-75	7.6	5.8	5.8	6.3

During winter period feed reserve substances are stored in roots, buds, aerian part of the pear plants (donor) and are used for intensive growth of the pear shoots, leaves and fruits (acceptor).

The measurements (tab. 5) were done at Noyabrskaya, Vystavochnaya variety with LCi-4, from 08:50 to 09:50 and 09:55 to 10:15 at Vystavochnaya variety.

The first measurement (30.05.2016), the second one (16.06.2016) and the third (07.07.2016) took place on the period of maximal growth of the pear shoots, leaves and fruits (tab.3, 4 and fig.6, 7).

The measurement 1, 2 and 3 are presented in table 5 made with LCi-4 in order to reflect the photosynthesis activity.

The intensity of photosynthesis for Noyabrscaya variety includes 6.88 – 16.07 µmol m^{-2} s^{-1} and for Vystavochnaya variety 3.30 – 6.07 µmol m^{-2} s^{-1}.

The intensity of transpiration is 0.74 – 1.12 mmol m^{-2} s^{-1} for Noyabrskaya variety and 0.92 – 1.31l m^{-2} s^{-1} for Vystavochnaya variety.

Photosynthetic active radiation is 1049-1090l m^{-2} s^{-1} at Noyabrskaya variety and 1286-1367 m^{-2} s^{-1} at Vystavochnaya variety.

T, ^0C – in the measurable room / of the leaf includs 23.4 / 28.08 for Noyabrskaya variety and 28.9/33.59 for Vystavochnaya variety.

Conductivity of the stomatas at CO_2 including 0.03-0.04mol m^{-2} s^{-1} Noyabrskaya variety and 0.04- 0.17 mmol m^{-2} s^{-1} Vystavochnaya variety.

The forth (21.07.2016), the fifth (12.08.2016) and the sixth (08.09.2016) measurements were done in the period of the end of vegetation period when the growth is much lower, and the process of storage in pear branches and roots started (donor).

The measurement 4, 5 and 6 are presented in table 5 made with LCi-4 in order to reflect the photosynthesis activity:

The intensity of photosynthesis for Noyabiscaya variety is 6.88 – 11.64 µmol m^{-2} s^{-1} and for Vystavochnaya variety 1.61 – 6.07 µmol m^{-2} s^{-1}.

The intensity of transpiration is 0.74 – 5.92 mmol m^{-2} s^{-1} at Noyabrskaya variety and 0.92 – 4.43 mmol m^{-2} s^{-1} at Vystavochnaya variety.

Photosynthetic active radiation is 780 - 1283 mmol m^{-2} s^{-1} for Noyabrskaya variety and 1022 - 1191 mmol m^{-2} s^{-1} for Vystavochnaya variety.

T, ^0C – in the measurable room / of the leaf is 21.5/27.56 for Noyabrskaya variety and 21.1/27.29 for Vystavochnaya variety.

Conductivity of the stomatas at CO_2 is 0.02 – 0.09 mmol m^{-2} s^{-1} for Noyabrskaya variety and 0.02 – 0.08 mmol m^{-2} s^{-1} for Vystavochnaya variety.

CONCLUSIONS

1. The results of the researches showed that the intensity of the photosynthetic processes in the application of SBA *Verbascozida* 0.01% is much higher compared to the control variant.

2. *Verbascozida* growth regulator at a concentration of 0.01% significantly alters the intensity of photosynthetic processes and determines the ability to form and transport of assimilates.

3. At the end of the vegetation period, the intensity of processes of photosynthesis, transport and use of photosynthetic products in both variants is the same.

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