RESEARCH REGARDING THE INTENSITY OF SOME PHYSIOLOGICAL PROCESSES IN *Citrullus lanatus* (THUNB.) MATSUM. & NAKAI IN GRAFTED PLANT CROPS

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Abstract. Research on the diurnal dynamics of physiological processes was made on watermelon plants (*Citrullus lanatus* (THUNB.) MATSUM. & NAKAI) grafted on *Lagenaria siceraria* (MOLINA) STANDLEY rootstock cultivated on sandy soil, in field conditions, at the CCDCPN, Dăbuleni, Dolj. The review showed that the diurnal dynamics of photosynthesis and transpiration vary depending on weather conditions, presenting minimum values in the morning, maximum values at midday and minimum values towards the evening, with specific variations in the grafted plants, compared with not grafted plants. The linear regressions performed between the photosynthesis rate and the photosynthetic active radiation of Crisby watermelon plants show a positive correlation (R^2 = 0.88 in grafted plants and R^2 = 0.73 in not grafted plants), while for Rica F1 plants also show a positive correlation (R^2 = 0.78 in grafted plants and R^2 = 0.71 in not grafted plants). The linear regressions performed between the transpiration rate and the photosynthetic active radiation of Crisby watermelon plants show a positive correlation between them (R^2 = 0.66 in grafted plants and R^2 = 0.95 in not grafted plants), while for Rica F1 plants also show a positive correlation (R^2 = 0.67 in grafted plants and R^2 = 0.68 in not grafted plants). The chlorophyll content in mature leaves of grafted plants is lower, between the content of chlorophyll pigments and the photosynthesis intensity being a positive correlation.

Keywords: chlorophyll, physiological processes, photosynthesis, transpiration, watermelon plants.

Rezumat. Cercetări privind intensitatea unor procese fiziologice la *Citrullus lanatus* (THUNB.) MATSUM. & NAKAI în culturi de plante altoite. Cercetările privind dinamica diurnă a proceselor fiziologice s-au efectuat la plantele de pepeni verzi (*Citrullus lanatus* (THUNB.) MATSUM. & NAKAI) altoite pe portaltoiul *Lagenaria siceraria* (MOLINA) STANDLEY, cultivate pe sol nisipos, în condiţii de câmp, la CCDCPN Dăbuleni, Dolj. La plantele analizate s-a constatat că dinamica diurnă a fotosintezei şi transpiraţiei variază în funcţie de condiţiile climatice, prezentând valori minime dimineaţa, valori maxime la prânz şi valori minime spre seară, cu variaţii specifice la plantele altoite, în comparaţie cu plantele nealtoite. Regresiile liniare realizate între rata fotosintezei şi radiaţia fotosintetic activă la plantele de pepeni verzi Crisby evidenţiază o corelaţie pozitivă (R^2 = 0,88 la plantele altoite şi R^2 = 0,73 la plantele nealtoite), iar la plantele Rica F1 evidenţiază, de asemenea, o corelaţie pozitivă (R^2 = 0,78 la plantele altoite şi R^2 = 0,71 la plantele nealtoite. Regresiile liniare realizate între rata transpiraţiei şi radiaţia fotosintetic activă la plantele de pepeni verzi Crisby F1 evidenţiază o corelaţie pozitivă (R^2 = 0,66 la plantele altoite şi R^2 = 0,95 la plantele nealtoite), iar la plantele Rica F1 evidenţiază, de asemenea, o corelaţie pozitivă (R^2 = 0,67 la plantele altoite şi R^2 = 0,68 la plantele nealtoite). Conţinutul în clorofilă la frunzele mature ale plantelor altoite este mai redus, între conţinutul în pigmenţi clorofilieni şi intensitatea fotosintezei existând o corelaţie pozitivă.

Cuvinte cheie: clorofilă, procese fiziologice, fotosinteză, transpiraţie, plante de pepeni verzi.

INTRODUCTION

The physiological investigations were carried out within the national research program (PN II), No. 52147 / 2008, entitled: "Research on the foundation and development of technology for cultivation of watermelon grafted plants, in order to obtain biological production in sandy soils areas".

The main objective of the project is to develop and promote in the sandy soils of Romania the technologies for obtaining biological watermelons grafted plant crops in order to increase the competitiveness and the profitability of agricultural exploitation.

The research refers to the watermelon culture *C. lanatus* (THUNB. MATSUM. & NAKAI) grafted on *Lagenaria siceraria* (MOLINA) STANDLEY - (Macis F1 hybrid) rootstock, the grafting plants determining an increase of plants resistance to stress factors, high production levels, the elimination of treatments regarding the ground combat pathogens, a better use of organic fertilizers accepted in biological agriculture.

The advantage of grafted plants is to reduce the number of plants used per hectare due to a more vigorous growth, to explore a larger volume of soil due to a very strong root of the rootstock favouring water and nutrient absorption, which leads to a better resistance to heat and water stress.

The watermelon plants grafting techniques have been expanded in recent years to boost plant growth and development, to control wilt caused by pathogens (YETISIR et al., 2003), to increase nutrient and mineral uptake to the shoot (RUIZ et al., 1997), to strengthen tolerance to thermal or saline stress (ROMERO et al., 1997) etc.

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

Intensity of transpiration process commensurate increases with that of photosynthesis, both processes are dependent on solar radiation intensity (BIGNAMI & NATALI, 1992).

MATERIAL AND METHODS

The physiological investigations were carried out on watermelon plants grown on sandy soil, in 2009, at the Agricultural Station of Research and Development for the Plant Culture on Sandy Soils (CCDCPN), Dăbuleni, Dolj.

The research consisted of analysing physiological watermelon hybrids (Crisby F1, Rica F1) grafted on the Macis F1 hybrid of *Lagenaria siceraria* species, compared with not grafted plants.

Crisby F1 is an extra-early hybrid to Crimson Sweet cultivars type, and Rica F1 is a late hybrid belonging to Sugar Baby cultivars type.

This paper's aim is to study physiological processes (photosynthesis rate, transpiration rate) of watermelon plants in accordance with environmental factors (light, temperature).

The intensity of photosynthesis and transpiration were made by using the portable photosynthesis analyser LCpro+, system which enables automatic recording and other parameters (photosynthetic active radiations, leaf temperature etc.). The obtained results were graphically represented and statistically interpreted.

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 physiological investigations were carried out on July 7th 2009 and consisted of analysing the diurnal dynamics of some physiological processes (photosynthesis rate, transpiration rate), establishing some correlations between these processes and the intensity of photosynthetic active radiation incident on the leaf surface, as well as establishing the chlorophyll pigments content in grafted plants, in comparison with not grafted plants.

The morphological aspect of grafted and not grafted watermelon plants, in the fruit maturing stage, of the Crisby F1 variety is shown in figures 1; 2, and of the Rica F1 variety is shown in figures 3; 4.

The diurnal dynamics of photosynthesis in the Crisby F1 and the Rica F1 watermelon plants presents low values in the morning due to low light intensity and temperature, and maximum values after lunch due to the growth of light intensity and temperature and of the opening degree of the stomata and low values in the evening due to the gradually decrease in the light intensity and temperature and low opening of the stomata (Figs. 5; 6).

The diurnal dynamics of transpiration in the Crisby F1 and the Rica F1 presents low values in the morning because of the minimum opening of stomata and of the low power of air dehydration, maximum values in the afternoon due to the increasing opening of the stomata according to the growth of the light intensity, temperature and of the power of air dehydration and generally low values in the evening because of the gradual decrease of light intensity and temperature (Figs. 7; 8).

The photosynthetic active radiations have a role in the induction of photosynthesis and transpiration by performing photoactive opening movements of the stomata and by increasing the leaves temperature.

The Crisby F1 watermelon plants have an increasing photosynthetic active radiation in the morning (9 a.m.) when the values are of 1,421 $\mu mol/m^2/s$ for grafted plants and of 1,228 $\mu mol/m^2/s$ for not grafted plants, they grow until after noon (1 p.m.) when the values are of 1,681 $\mu mol/m^2/s$ for grafted plants and of 1,620 $\mu mol/m^2/s$ for not grafted plants, while towards the evening (5 p.m.) the values decrease gradually to 1,494 $\mu mol/m^2/s$ for grafted plants and to 1,461 $\mu mol/m^2/s$ for not grafted plants. The linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.88 for grafted plants and of 0.73 for not grafted plants (Fig. 9).

The Rica F1 watermelon plants have an increasing photosynthetic active radiation in the morning (9 a.m.) when the values are of 1,330 $\mu mol/m^2/s$ for grafted plants and of 1,589 $\mu mol/m^2/s$ for not grafted plants, they grow until after noon (1 p.m.) when the values are of 1,609 $\mu mol/m^2/s$ for grafted plants and of 1,774 $\mu mol/m^2/s$ for not grafted plants, while towards the evening (5 p.m.) the values decrease gradually to 1,571 $\mu mol/m^2/s$ for grafted plants and to 1,601 $\mu mol/m^2/s$ for not grafted plants. The linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.78 for grafted plants and of 0.71 for not grafted plants (Fig. 10).

At the Crisby F1 watermelon plants, the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.66 for grafted plants and of 0.95 for not grafted plants (Fig. 11).

At the Rica F1 watermelon plants, the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation between the two analysed factors, the coefficient of determination (R^2) being of 0.67 for grafted plants and of 0.68 for not grafted plants (Fig. 12).

The temperature, along with the solar radiation intensity, represents the main external factor which influences the processes of photosynthesis and transpiration. The research carried out on the dynamics of air temperature at the time of physiological tests, show an increasing level in the morning (9 a.m.), when the values are of 26°C, an increasing temperature at noon (1 p.m.), when the values are of 30.4°C, and further increasing temperature in the evening (5 p.m.), when the values are of 37°C, after which the temperature begins to decrease gradually.

The chlorophyll content. The mature leaves of grafted plants compared with not grafted plants, show a slight decrease in chlorophyll content of 6.40% for Crisby F1 and of 1.69% for Rica F1 as a result of a gradual deterioration of chlorophyll pigments as leaf growth ceases, and the produced organic substances migrate and accumulate in the fruit (Fig. 13).

Figure 1. *Citrullus lanatus* (Crisby F1) - grafted plants.
Figura 1. *C. lanatus* (Crisby F1) - plante altoite (original).

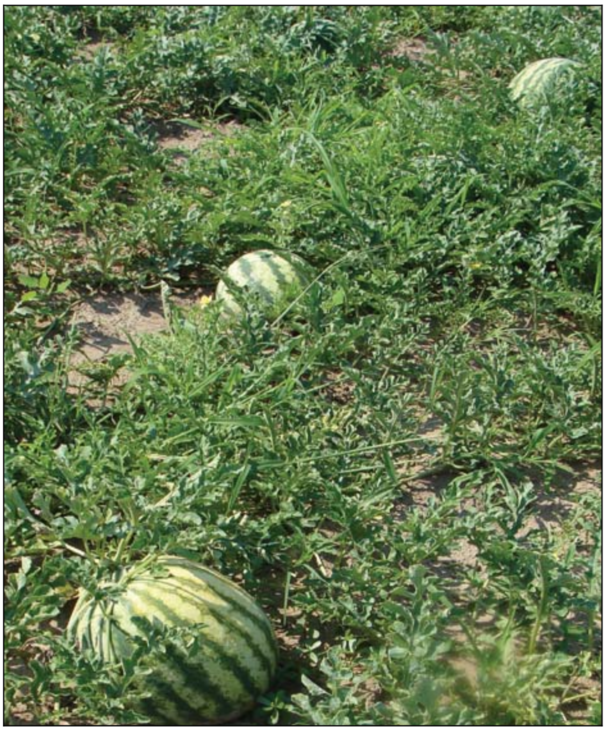

Figure 2. *Citrullus lanatus* (Crisby F1) - not grafted plants.
Figura 2. *C. lanatus* (Crisby F1) - plante nealtoite (original).

Figure 3. *Citrullus lanatus* (Rica F1) - grafted plants.
Figura 3. *C. lanatus* (Rica F1) - plante altoite (original).

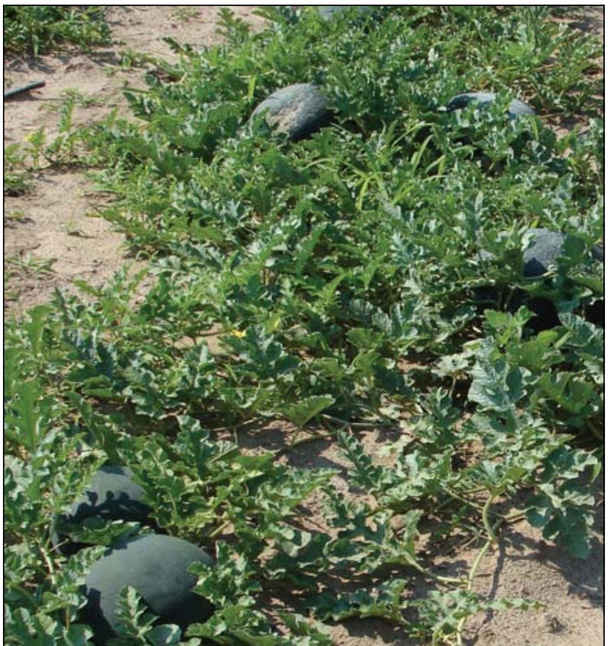

Figure 4. *Citrullus lanatus* (Rica F1) - not grafted plants.
Figura 4. *C. lanatus* (Rica F1) - plante nealtoite (original).

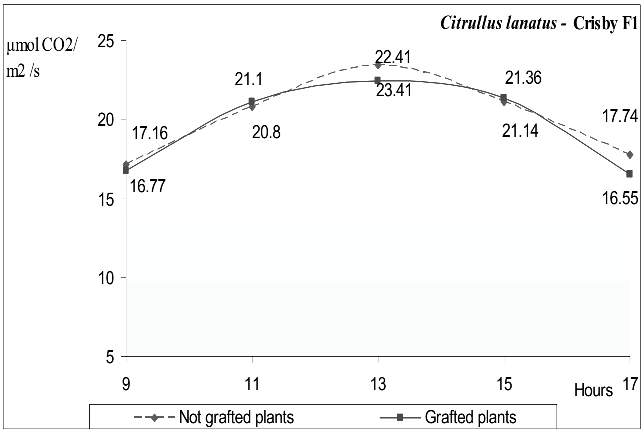

Figure 5. The diurnal dynamics of photosynthesis at the leaves of *Citrullus lanatus* - Crisby F1.
Figura 5. Dinamica diurnă a fotosintezei la frunzele de *C. lanatus* - Crisby F1.

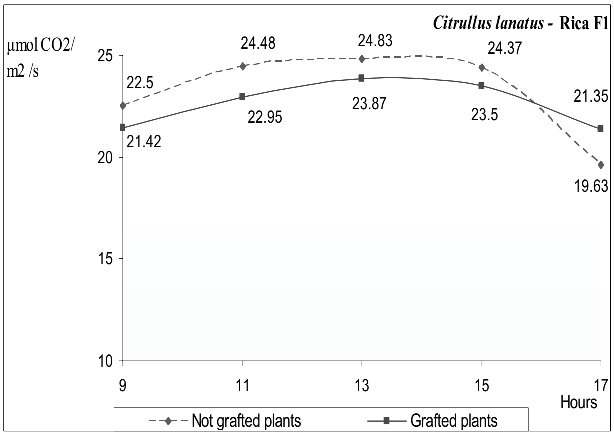

Figure 6. The diurnal dynamics of photosynthesis at the leaves of *Citrullus lanatus* - Rica F1.
Figura 6. Dinamica diurnă a fotosintezei la frunzele de *C. lanatus* - Rica F1.

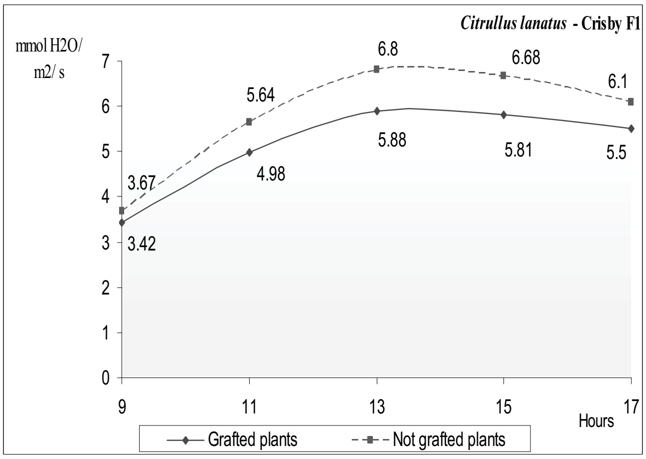

Figure 7. The diurnal dynamics of transpiration at the leaves of *Citrullus lanatus* - Crisby F1.
Figura 7. Dinamica diurnă a transpirației la frunzele de *C. lanatus* - Crisby F1.

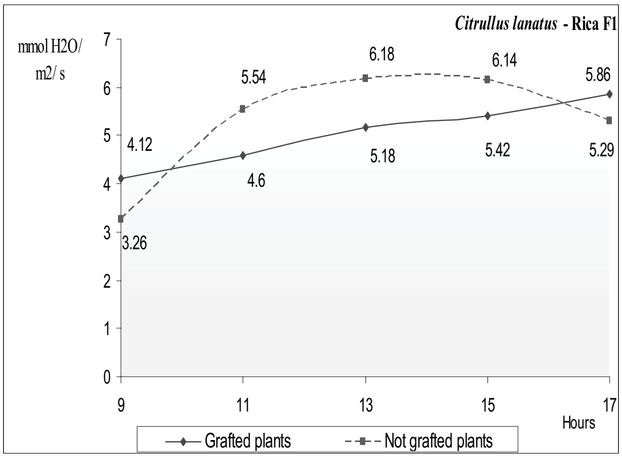

Figure 8. The diurnal dynamics of transpiration at the leaves of *Citrullus lanatus* - Rica F1.
Figura 8. Dinamica diurnă a transpirației la frunzele de *C. lanatus* - Rica F1.

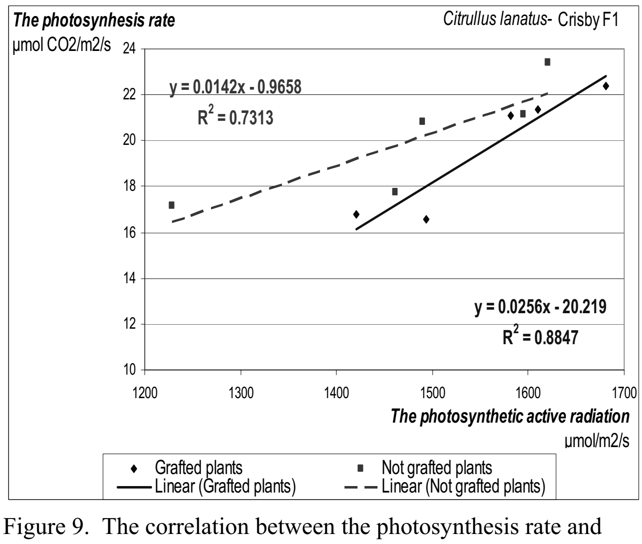

Figure 9. The correlation between the photosynthesis rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Crisby F1.
Figura 9. Corelații între rata fotosintezei și radiația fotosintetic activă la frunzele de *C. lanatus* - Crisby F1.

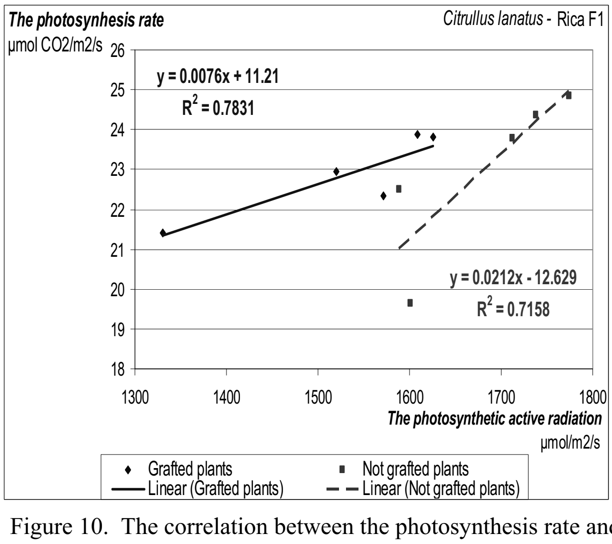

Figure 10. The correlation between the photosynthesis rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Rica F1.
Figura 10. Corelații între rata fotosintezei și radiația fotosintetic activă la frunzele de *C. lanatus* - Rica F1.

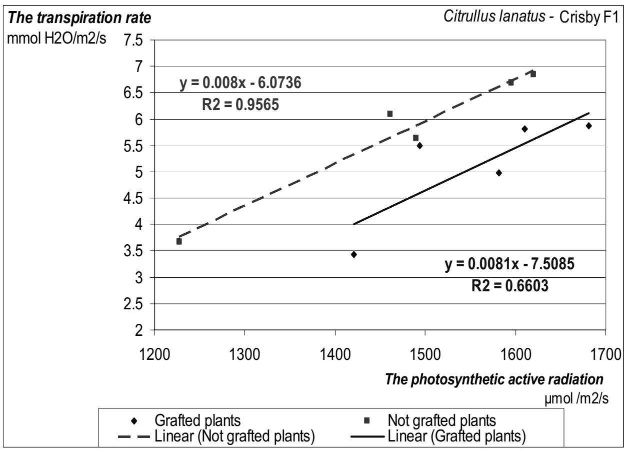

Figure 11. The correlation between the transpiration rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Crisby F1.
Figura 11. Corelaţii între rata transpiraţiei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Crisby F1.

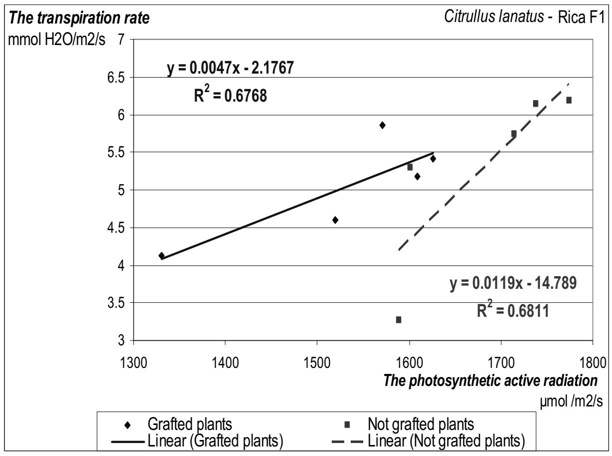

Figure 12. The correlation between the transpiration rate and the photosynthetic active radiation at the leaves of *Citrullus lanatus* - Rica F1.
Figura 12. Corelaţii între rata transpiraţiei şi radiaţia fotosintetic activă la frunzele de *C. lanatus* - Rica F1.

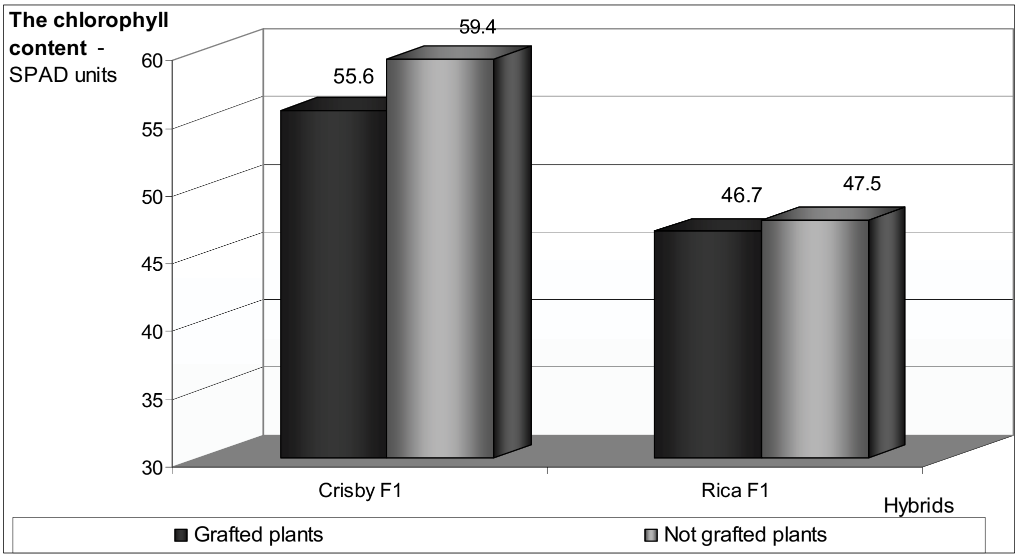

Figure 13. The chlorophyll content at the leaves of *Citrullus lanatus.*
Figura 13. Conţinutul de clorofilă la frunzele de *C. lanatus.*

CONCLUSIONS

The research carried out on grafted watermelon plants revealed the diurnal dynamics of the physiological processes, and allowed to establish a correlation between these processes and the photosynthetic active radiation intensity, and also evidenced the chlorophyll pigment content in grafted plants compared with not grafted plants.

The diurnal dynamics of photosynthesis in watermelon plants shows minimum values in the morning, maximum values at noon and minimum values towards the evening, but the values recorded in grafted plants are smaller compared with not grafted plants. At the Crisby F1 watermelon plants the linear regressions performed between the values of photosynthesis rate and the photosynthetic active radiation, show a positive correlation, the coefficient of determination (R^2) being of 0.88 for grafted plants and of 0.73 for not grafted plants, while for the Rica F1 plants the linear regressions performed also show a positive correlation, the coefficient of determination (R^2) being of 0.78 for grafted plants and of 0.71 for not grafted plants.

The diurnal dynamics of the transpiration shows minimum values in the morning, maximum values at noon and minimum values in the evening, but the values recorded in grafted plants are smaller compared with not grafted plants. At Crisby F1 watermelon plants the linear regressions performed between the values of transpiration rate and the photosynthetic active radiation, show a positive correlation, the coefficient of determination (R^2) being of 0.66 for grafted plants and of 0.95 for not grafted plants, while for the Rica F1 plants the linear regressions performed also positive correlation, the coefficient of determination (R^2) being of 0.67 for grafted plants and of 0.68 for not grafted plants.

The chlorophyll content in the mature leaves of grafted plants is lower, in comparison with the chlorophyll content of not grafted plants, as between the content of chlorophyll pigments and photosynthesis intensity is a positive correlation.

REFERENCES

BIGNAMI C. & NATALI S. 1992. *Relazioni idriche e fotosintesi di alcune specie da frutto*. Giornate Scientifiche SOI / Societa Orticola Italiana. Ravello: 174-175.

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

ROMERO L., BELAKBI. A., RAGALA L., RUIZ J. M. 1997. *Response of plant yield and leaf pigments to saline conditions: effectiveness of different rootstocks in melon plants (Cucumis melo* L*.).* Soil Science, Plant Nutrition. **43**: 855-862.

RUIZ J. M., BELAKBIR A., LOPEY-CANTARERO I., ROMERO I. 1997. *Leaf - macronutrient content and yield in grafted melon plants. A model to evaluate the influence of rootstock genotype*. Scientia Horticulturae. **71**: 227-234.

YETISIR H., SARI N., YUCEL S. 2003. *Rootstock rezistence to Fusarium wilt and effect on watermelon fruit yield and quality.* Phytoparasitica. **31**: 163-169.

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