THE INFLUENCE OF PLANTING DENSITY ON THE EFFICIENCY OF PHOTOSYNTHESIS AT AN ASSORTMENT OF TOMATOES GROWN IN POLLYTUNNELS, IN ECOLOGICAL CONDITIONS

INFLUENȚA DENSITĂȚILOR DE PLANTARE ASUPRA EFICIENȚEI PROCESULUI DE FOTOSINTEZĂ LA UN SORTIMENT DE TOMATE CULTIVATE ÎN SOLAR, ÎN CONDIȚII ECOLOGICE

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Abstract. *The paper aims to assess the ecological plasticity of tomato cultivars to specific cultural conditions, expressed by the efficiency of photosynthesis process. The increase of the photosynthesis rate, along with the transpiration rate in optimal hydratation and temperature conditions occurs due to stimulation of the stomatal opening degree. The stomatal reaction is a response to water availability to adjacent tissues and results in an increasing of perspiration. Having direct influence on the growth and yield, the total content of chlorophyll pigments was determined in vivo, revealing the predominant influence of the genotype.*
Keywords: *ecological tomatoes, photosynthesis process, stomatal conductivity, total content of chlorophyll pigments*

Rezumat. *Lucrarea își propune să evalueze plasticitatea ecologică a cultivarelor de tomate la anumite condiții de cultură, exprimată prin eficiența procesului de fotosinteză. Creșterea ratei fotosintezei, însoțită de creșterea ratei transpirației, în condiții de hidratare și temperatură optime are loc datorită stimulării gradului de deschidere al stomatelor. În cazul tomatelor, reacția stomatelor este un răspuns la disponibilitatea apei pentru țesuturile adiacente și are ca efect o creștere a ratei transpirației. Conținutul total în pigmenți clorofilieni, influențând în mod direct creșterea și productivitatea, a fost determinat in vivo, relevând preeminența influenței genotipului.*
Cuvinte cheie: *tomate ecologice, fotosinteza, conductivitate stomatală, conținutul total de pigmenți clorofilieni.*

INTRODUCTION

The evaluation of the cultivars ecological plasticity to specific cultural conditions is an important step in researches regarding the study of the photosynthesis process due to its high sensitivity to a number of environmental factors.

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Researches conducted by various authors indicate that the intensity of the photosynthesis process is higher on plants grown in open field to those grown under controlled conditions (greenhouses or pollytunnels). Mainly, these variations are caused by the differences in the quantity and quality of light (synthesis by Schwarz, 2002).

The paper aims to evaluate the ecological plasticity of tomato cultivars to specific cultural conditions, expressed in the efficiency of the photosynthesis process.

MATERIAL AND METHOD

The researches were conducted during the 2012 year in the vegetable growing experimental field from "V. Adamachi" farm belonging to UASVM Iași, in two pollytunnels, on a tomato culture with seedling produced at alveolar pallets (without subculturing procedure).

The bifactorial experience (table 1) was organized in a subdivided plots device with three repetitions, each plot containing ten plants.

Table 1

Tehnological factors graduation

A factor (Cultivar)	B factor (Distance between plants / row)
a1 = Margarita F1	**b1** = 33 cm (33.670 plants/ha)
a2 = Primadona F1	
a3 = Winona F1	**b2** = 40 cm (27.778 plants/ha)
a4 = Belladona F1	
a5 = Siriana F1	**b3** = 50 cm (22.223 plants/ha)
a6 = Buzău 1600	

Photosynthesis rate (A), stomatal conductivity (gS), transpiration rate (E) and water use efficiency (A / E) were measured in pollytunnel cultivation conditions (t = 15 °C - 16°C, humidity = 78% - 84%, photosynthetic active light intensity PAR 500-600 micromol mol^{-1}) with gas analyzer device (600 LCi, ADC BioScientific Ltd., England). Measurements were performed on three leaves / plant and three repetitions meaning nine measurements / variant.

The total content of chlorophyll pigments was determined in vivo using the CCM-200 Chlorophyll Content Meter plus device. The results are shown in table 2.

Table 2

The description of physiological indicators determined in the experiment

Physiological indicator	Symbol	Measurement unit
Photosynthesis rate	A	µmol CO_2 $m^{-2}s^{-1}$
Transpiration rate	E	mmol H2O $m^{-2}s^{-1}$
Water use efficiency	WAE	A/E
Stomatal conductivity	gs	mol CO_2 $m^{-2}s^{-1}$
Total content of chlorophyll pigments	CCI	relative units

RESULTS AND DISCUSSIONS

Pollytunnel environmental conditions differ widley from those acting at an open field culture.

The data that we have obtained (figure 1) showed that the photosynthesis rate at tomato hybrids grown in pollytunnels is between 3,6 µmol $CO_2/m^{-2}\cdot s^{-1}$ at Siriana F1 x 33 cm variant and 5,92 µmol $CO_2/m^{-2}\cdot s^{-1}$ at Buzau 1600 x 50 cm variant. These data are in accordance with those obtained by other authors (Kosobryukhov, 2000).

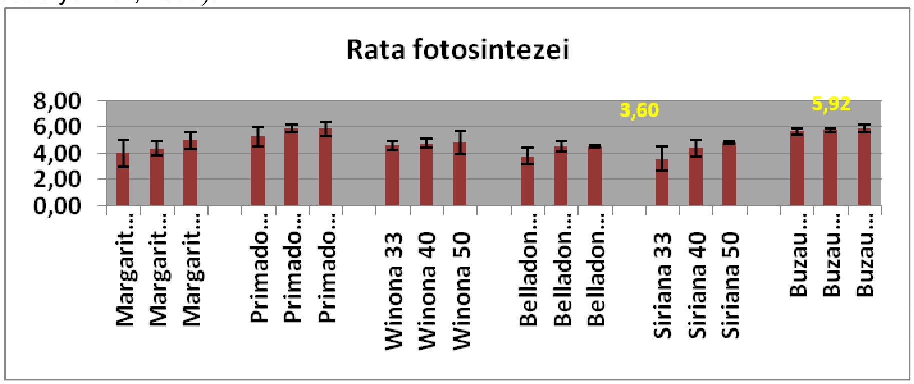

Fig. 1 - Photosynthesis rate at tomato hybrids grown in pollytunnels

The compensation of photosynthesis losses by increasing the fixation of carbon dioxide to the amount of photons absorbed is determined by the adaptation to low light intensity (Logan, 1998). Particularly, in this process, stomatal conductivity occurs associated with the rate of photosynthesis and light intensity and less with soil's water availability and transpiration rate (Wayne and Van Auken, 2009). This can be influenced by plant's phenological phase, temperature or other environmental factors (Ogle and Reynolds, 2002).

Regarding the transpiration rate, it varied within a fairly wide spectrum, with a minimum at Siriana F1 x 33 cm variant (2,48 mmol H_2O / $m^{-2}*s^{-1}$) and a maximum at Buzau 1600 x 40 cm variant (4,79 mmol H_2O / $m^{-2}*s^{-1}$) (fig. 2).

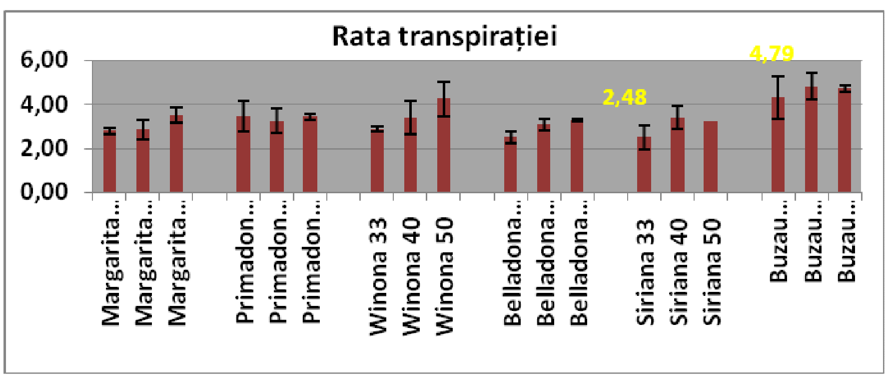

Fig. 2 - Transpiration rate at tomato hybrids grown in pollytunnels

Water use efficiency (figure 3), expressed as the ratio between the photosynthesis rate and transpiration rate, highlights the Winona F1 x 50 cm (1.13) and Primadonna F1 x 40 cm (1.83) as limit variants.

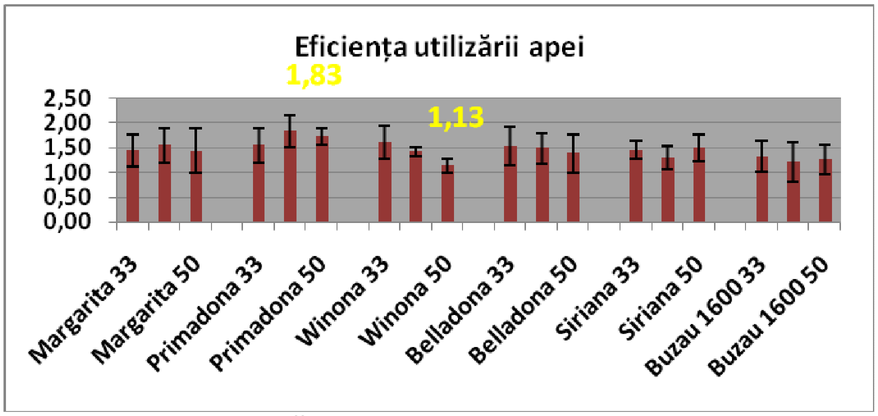

Fig. 3 - Water use efficiency at tomato hybrids grown in pollytunnels

The main internal factor that influences stomatal conductivity is the turgor of epidermal and stomatal cells (Wu, Sharpe and Spence 1985; Mencuccini, Mambelli and Comstock, 2000; Franks et al., 2001), the regulation of this turgor taking place by energy consumption (Farquhar and Wong, 1984; Assman, 1999; Blatt, 2000; Netting, 2000). Turgor is the result of a balance between the amount of water lost by perspiration process and the one absorbed from soil at the roots level. (Cowan, 1977; Mott and Parkhurst, 1991; Maier-Maercker, 1999; Mott and Franks, 2001).

Siriana x 33 cm variant registered the lowest stomatal conductivity (0,10 mol H_2O/m^{-2} s^{-1}) and Margarita x 50 cm variant – the highest (0,32 mol H_2O/m^{-2} s^{-1}) (figure 4).

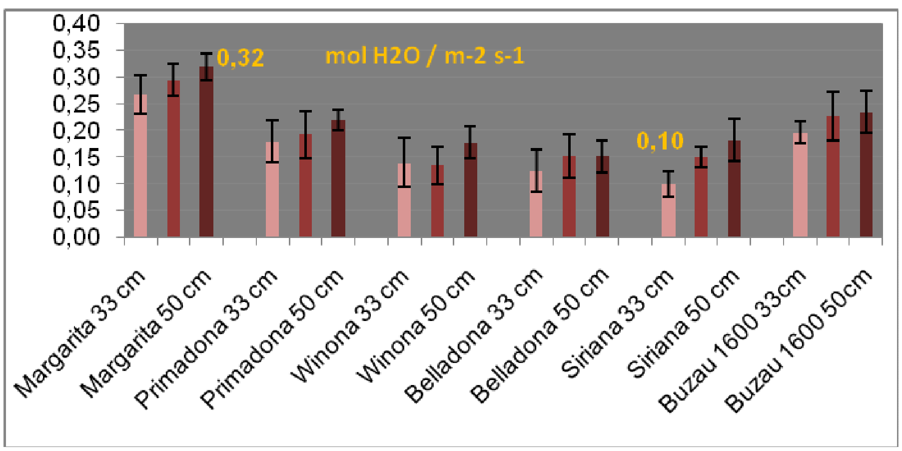

Fig. 4 - Stomatal conductivity at tomato hybrids grown in pollytunnels

There is a positively corelation between total chlorophyll content and growth and yield (Ramadasan et al., 1993, cited by Vijitha and Mahendran, 2010).

Adaptability of plants to low light intensities is closely related to a number of internal factors, of which the most important are fotosistems efficiency (particularly PSII) and relative chlorophyll content (Griffin et al., 2004).

All variants showed the minimum content of total chlorophyll at 33 cm between plants/row and the maximum content at 50 cm between plants/row, the distance between plants/row having a direct influence on the total chlorophyll content.

Interaction of the two factors show two distinct limit variants: Buzau 1600 x 40 cm variant (38,93 relative units) and Siriana F1 x 50 cm variant (67,08 relative units) (figure 5).

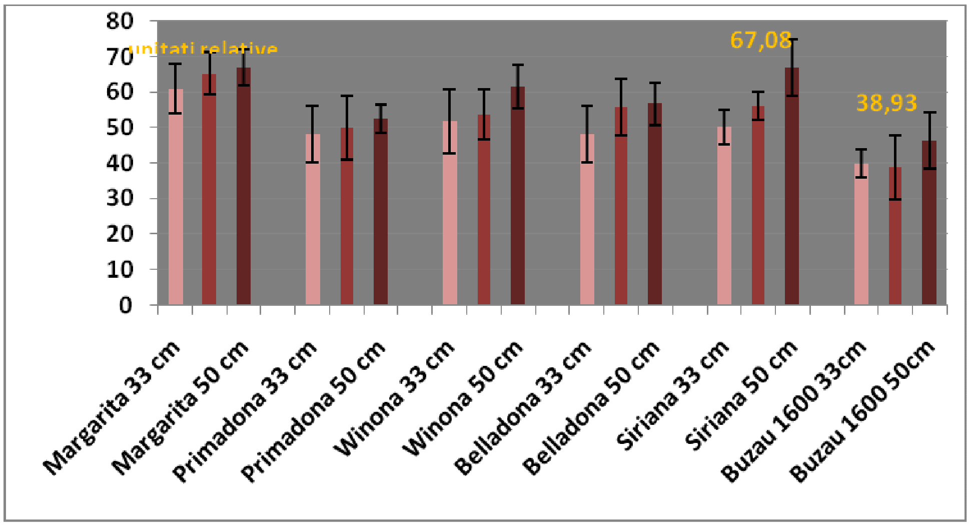

Fig. 5 - Total chlorophtll content at tomato hybrids grown in pollytunnels

CONCLUSIONS

1. In almost all cases, decreasing the distance between plants/row results in the decrease of the photosynthesis rate, due to increasing the shading of plants or to plant competition for water and soil.

2. Stomatal conductivity and total content of chlorophyll pigments increased proportionally to the distance between plants/row, while the influence of planting densities on the transpiration rate and water use efficiency was found to be stochastic.

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