RESEARCH ON THE BEHAVIOR OF AN ASSORTMENT OF BELL PEPPER ON THE SANDY SOILS IN SOUTH-WEST OLTENIA ACCORDING TO THE CULTIVATION METHOD USED

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ABSTRACT

The pedo-climatic conditions specific to sandy soils in southwest Oltenia determine differences in performing different phenophases of growth and development of plants, both between varieties and in the physiological behavior of the same variety under different yield conditions. Therefore, at the Dăbuleni Research and Development Station for Plant Culture on Sands, research was carried out on some physiological, biochemical and production processes at five varieties of bell peppers cultivated in the open fields and solar. Determinations of photosynthesis, foliar transpiration, the biochemical composition of fruits, quantity, and quality of bell pepper production were performed. The physiological and biochemical processes studied were influenced by the environmental conditions specific to each cultivation method, but also by the studied variables. Of the 5 varieties studied, the best results on the biochemical composition of the fruits were recorded at the *Artim* variety (8.83% total dry substance, 4.60% soluble dry substance, 0.19% acidity, 3.80% carbohydrate and 36.96% vitamin C). The production was between 15,387 t / ha for open-field plants and 108,574 t / ha for plants grown in the solar, the differences between the two cultivation methods being statistically assured as distinctly significant.

Keywords: *bell pepper, photosynthesis, foliar transpiration, biochemical composition, production*

INTRODUCTION

Global climate change, customized at a regional level, requires a competent revision of the structure of vegetable crops and the implicitly used cultivars, with high adaptability to the new conditions generated by climate change. Replacing old cultivars with new, performant ones should be limited to the interest of agricultural producers to cultivate the most valuable, without the risk of their non-adaptability either to the specific climatic and soil conditions or to the technology practiced. The normal conduct of metabolic processes in plants is carried out only if environmental conditions are provided for the requirements of each species, for each species taking into account an environmentally friendly optimum as a whole of the conditions under which the plants grow and develop normally (temperature, light, humidity, air, soil). The pedo-climatic conditions specific to the sandy soils of Southern Oltenia (sandy soils with reduced natural fertility, high temperatures and insufficient precipitation during the vegetation period, spread unevenly) determine differences in the various fenofases of growth and development, both between varieties and the behaviour of the same variety in different conditions of culture [4]. Internationally, in the field of vegetable growing research has been geared towards diversifying the assortment of species, creating high-performance cultivars, with great productivity and continuous improvement of cultivation technologies. There is a series of research on the influence of environmental factors (temperature, water, luminous intensity, mineral substances, etc.) on the conduct of physiological processes in plants, as well as on production obtained. If the level of these factors does not fall within the optimum limits, they are sources of stress, the emphasis of research being placed on physiological disorders occurring in the vegetal organisms subjected to abiotic stress. After Hall (2001) [3] heat stress is caused by the temperature whose level, duration of exposure and growth rate can cause damage to plants. Klueva et all (2001) [5] considers that the upper-temperature limits to which plants can survive are between 40-55 °C and vary according to species and duration of exposure. Exposure of peppers to temperatures higher than 38-40 °C determines, after Rabinowitch et all [7], the generation of superoxide radicals, by the action of light on chlorophyll. The lesions are characterized by the appearance of a whitish color and some small blisters, on the epicarp of the fruit. In a more advanced phase, water loss and tissue death are found. Cell death provides good conditions for the development of parasitic microorganisms, especially for Alternaria spp. Exposure of peppers at a temperature of 40 °C for 6 hours resulted in the reduction of this physiological disease [6]. Elena Ciuciuc and Marieta Ploae (2012) [1] have shown that by protecting the crops of bell pepper and eggplant, there are different conditions of microclimate with influence on the conduct of the main physiological processes in plants. Starting from the premise that the technology ensures the productive and qualitative potential of the variety, research carried out within the Research and Development Station for Plant Culture on Sands Dăbuleni on pepper culture on the sandy soils of south-west Oltenia acquires great importance in the scientific substantiation of cultivation technologies with detailed physiological and biochemical studies on the resistance or tolerance of plants to abiotic stress factors can be established.

MATERIALS AND METHODOLOGY

In order to scientifically substantiate the technologies of culture through physiological researches, both in the open field and in protected space (solar) culture in 2018, physiological, biochemical and production studies were initiated on 5 cultivars of bell pepper following to be recommended most valuable, both in terms of resistance to area-specific stressors, as well as quantitatively and qualitatively.

The experience was bifactorial, based on the subdivision parcel method, in 3 repetitions.

In each variant, were planted at the beginning of May 10 plants/row at a distance of 70 cm between the rows and 30 cm between plants per row, the surface area of one variant being 2.1 m^2.

It has been applied the cultivation technology of the bell pepper, developed by the Research and Development Station for Plant Culture on Sands Dăbuleni.

The variants of the experience were:

Factor A - Method of cultivation:
a_1 - open field culture;
a_2 - protected culture (in the solar).

Factor B – the cultivar:
b_1 – Artim;
b_2 – Barbara;
b_3 – Işalniţa 85V;
b_4 – Karola;
b_5– Şimnic.

One month after planting, determinations of the diurnal variation of photosynthesis, foliar transpiration, stomatal conductance were performed in five moments of the day, using the portable LC Pro+ photosynthesis assay system. To determine the quality of the bell pepper, the fruit was harvested at the technological maturity, and in the laboratory the following determinations were made:

- water and total dry matter (%) - gravimetric method;
- soluble dry substance (%) - refractometric method;
- vitamin C (mg/100 g fresh substance) - iodometric method;
- titratable acidity (g malic acid at 100 g fresh substance) - titrimetric method;
- carbohydrate content (%) - Fehling-Soxlet method.

The determination of production was made in dynamics as the bell pepper fruits matured, the data obtained being calculated and interpreted statistically by analysis of the variance and by the mathematical functions.

Climate conditions were monitored using the weather station of the Research and Development Station for Plant Culture on Sands Dăbuleni.

RESULTS AND DISCUSSIONS

From a climatic point of view, 2018 was a warm year, rich in rainfall, the monthly sums being much higher compared to the multi-annual sum of precipitation. The data recorded at the meteorological station of the Research and Development Station for Plant Culture on Sands Dăbuleni are presented in *table 1*.

Generally, Capsicum annum is pretentious to light, temperature, and humidity. The climatic conditions specific to May, June and July 2018 have particularly influenced the unprotected pepper culture. A large amount of rainfall recorded, compared to the multiannual amount of rainfall recorded between 1956 and 2016, led to the intensification of the physiological processes at the foliar level, but the high number of warm and humid days also showed a number of disadvantages related to the higher frequency of disease and pests, with direct influence on the production obtained in unprotected plants. On the other hand, one month after planting, precipitations were accompanied by hail, which caused leaf damage, with major implications for the normal development of the metabolism of plants grown in the open field (*Figure 1, a, b*).

Table 1.*Climatic conditions recorded during the growing season of bell pepper (2018)*

Year	Climatic element	Month				
		May	June	July	August	September
2018	Medium temperature (°C)	20,7	22,5	23,6	25,1	21,6
	Minimum temperature (°C)	10,6	9,0	14,1	14,1	14,0
	Maximum temperature (°C)	31,8	35,7	34,9	35,7	30,7
	Precipitations (mm)	106,6	195,2	147,9	30	12,6
	Atmospheric relative humidity (%)	73	79	79,2	73,2	67,8
Multiannual medium temperature (1956-2016)		16,8	21,6	23,1	22,4	17,8
Precipitations, multiannual total (1956-2016)		62,12	69,30	53,15	37,28	47,83

Protected crop

Open field crop

Fig. 1. *Aspects in the experimental field (a. Protected crop; b. Open field crop) one month after planting*

The results on the diurnal variation of photosynthesis (*Figure 2*) showed a slightly different behavior of the five cultivars of peppers depending on the cultivation method used. The average daily CO2 accumulation was between 19.13 µmol $CO_2/m^2/s$ for plants grown in the sun and 22.73 µmol $CO_2/m^2/s$ for open-field plants.

The process of transpiration was more intense in plants grown in the open field, because during the period when the determinations were made, the leaves of the pepper were affected by the hailstones. Most varieties studied showed the maximum values of transpiration at noon, the differences between cultivars being insignificant (*figure 3*).

The average daily sweat was between 5.26 mmol $H_2O/m^2/s$ at protected plants and 6.80 mmol $H_2O/m^2/s$ at unprotected plants.

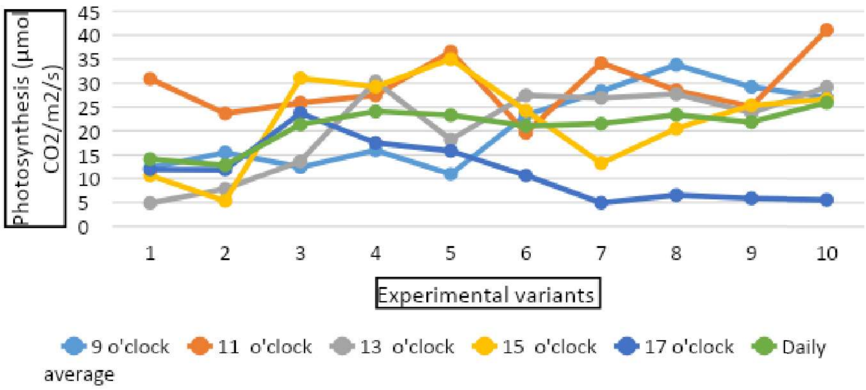

Fig. 2. *Daily variation of photosynthesis depending on variety and cultivation method*

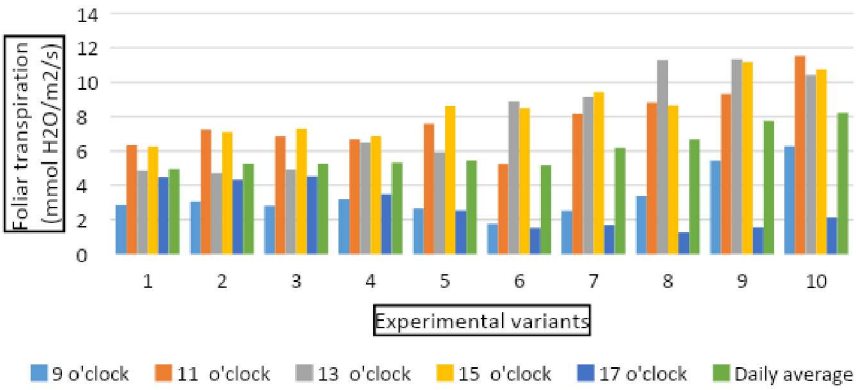

Fig.3. *Daily variation of foliar transpiration depending on variety and cultivation method*

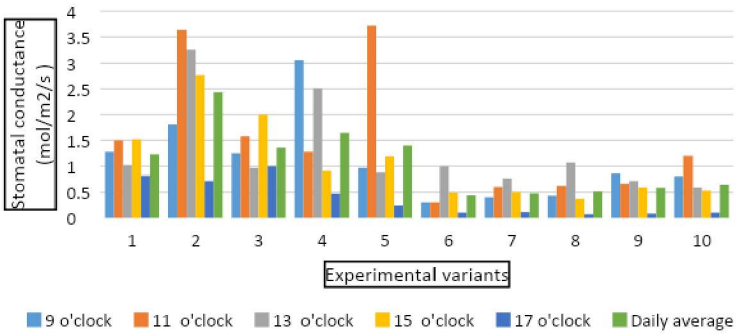

Fig. 4. *Daily variation of stomatal conductance depending on variety and cultivation method*

Figure 4 shows results on stomatal conductance values. It can be noticed that the microclimate provided by the protection of the sweet pepper culture favoured the opening of the stomata. The differences between the varieties were insignificant, but there were differentiations related to the time of the determinations and the method of cultivation used. The average stomatal conductance was between 0.52 mol/m²/s for open-field plants and 1.61 mol/m²/s for protected plants.

The results of the quality indices are presented in *table 2*. These results highlight the influence of the cultivar studied and the cultivation method. The total dry substance was between 4.75% for cultivar Barbara in the protected variant and 10.05% for Artim cultivar in the protected variant.

Table 2. *Influence of the cultivation method and cultivar on the biochemical composition of the bell pepper*

Cultivar	Cultivation method	Dry substance (%)	Water (%)	Soluble dry substance (%)	Acidity (g of malic acid/100g fresh substance)	Carbohydrates (%)	C vitamin (mg/100g fresh substance)
Artim	Solar	10,05	89,95	4,60	0,23	3,80	36,96
	Open field	7,61	92,39	4,60	0,14	3,80	36,96
Barbara	Solar	4,75	95,25	4,00	0,18	3,35	29,04
	Open field	6,92	93,08	5,00	0,17	4,17	45,36
Ișalnița 85V	Solar	6 ,88	93,12	4,20	0,24	3,50	25,52
	Open field	8,02	91,98	4,20	0,16	3,50	41,36
Karola	Solar	6,26	93,74	4,00	0,22	3,30	27,28
	Open field	6,96	93,04	4,00	0,19	3,30	30,28
Șimnic	Solar	6,78	93,22	4,20	0,20	3,47	29,92
	Open field	9,22	90,78	4,20	0,19	3,46	41,36

In all cultivars studied, less Artim cultivar, higher values of total dry substance content were obtained in unprotected variant. With the accumulation of a total dry substance in peppers, the amount of water in the fruit decreases. The amount of soluble dry substance was less influenced by the protection system and ranged between 4% and 5%. The carbohydrate content of the peppers ranged from 3.30% to Karola irrespective of the protection system and 4.17% in Barbara cultivar in the unprotected system.

The titratable acidity (TA) in fruit and vegetables is used together with carbohydrates as an indicator of maturity [2].

The acidity of the pepper fruit was between 0.14 g malic acid/100 g fresh substance in Artim cultivar in unprotected variant and 0.24 g malic acid/100 g fresh substance in the cultivar Isalniţa 85V in the protected variant. In unprotected variants, acidity values were lower in all cultivars than in solar. The amount of pepper vitamin C was quite low. It ranged from 27.28 mg to Karola cultivar in the solar and 45.36 mg to Barbara in the unprotected variant.

Research by Zoran S. Ilić et al., 2017 [8], found in peppers that the highest concentration of soluble dry substance (SUS) was determined in open-field pepper (8.03%). Fruit peppers obtained in plastic tunnels had a significantly lower SUS content (6.58%). Total acidity was 0.19% in open-field and 0.25% in fruit grown in plastic tunnels. The highest concentration of vitamin C was determined in the pepper cultivated in plastic tunnels (175.77 mg 100 g^{-1}). Only limited data has been found in the literature that has as subject the vitamin C content of pepper in response to growing conditions, especially variations in solar radiation and temperature. Vitamin C from pepper has been affected by cultural practices (genotype and agronomic technique) on the one hand (Topuz, Ozdemir, 2007) and abiotic factors (light and temperature) on the other hand (López-Marín et al., 2011).

Unprotected plants were affected by the climatic conditions of 2018, the abundance of rainfall in May-July with negative impacts on production obtained (*table 3*). Between the two methods of cultivation, there were distinctly significant differences, statistically ensured, detaching the Simnic cultivar, with an average production of 69 t / ha.

Table 3. *Interaction of cultivar x cultivation method influence on production*

Interaction of cultivar x cultivation method		Production (t/ha)	The difference (t / ha)	Signification
Artim	Open field	14,666	Control variant	
	Solar	94,022	+79,356	**
Barbara	Open field	12,951	Control variant	
	Solar	109,269	96,318	**
Işalniţa 85V	Open field	18,015	Control variant	
	Solar	111,377	+93,362	**
Karola	Open field	16,253	Control variant	
	Solar	104,999	+88,746	**
Şimnic	Open field	15,05	Control variant	
	Solar	123,202	+108,152	**
DL 5% = 28,582 t/ha DL 1% = 55,974 t/ha DL 0,1% = 151,373 t/ha				

CONCLUSION

Different cultivation methods determine differences in performing different phenophases of growth and development of pepper plants cultivated on sandy soils from Romania.

The physiological and biochemical processes studied were influenced by the environmental conditions specific to each cultivation method, but also by the studied cultivars.

Of the 5 varieties studied, the best results on the biochemical composition of the fruits were recorded at the *Artim* variety (8.83% total dry substance, 4.60% soluble dry substance, 0.19% acidity, 3.80% carbohydrate and 36.96% vitamin C). The production was between 15,387 t / ha for open-field plants and 108,574 t / ha for plants grown in the solar, the differences between the two cultivation methods being statistically assured as distinctly significant.

REFERENCES

[1] Ciuciuc Elena, Ploae Marieta, Studiul microclimatului creat prin protejarea culturii de ardei gras şi impactul acestuia asupra plantelor pe solurile nisipoase. Anale ICDLF Vidra, Romania, 2012.

[2] F. Gonzalez-Cebrino1 , M. Lozano1 , M. C. Ayuso2 *, M. J. Bernalte2 , M. C. Vidal-Aragon3 and D. Gonzalez-Gomez, Characterization of traditional tomato varieties grown in organic conditions, Spanish Journal of Agricultural Research 2011 9(2), 444-452.

[3] Hall A. E., Crop Responses to the Environment, CRC Press, Boca, 2001.

[4] Ifrim A., Buică V., Cercetări privind comportarea unor soiuri şi linii de pătlăgele vinete pe solurile nisipoase din sudul Olteniei, Lucrări Ştiinţifice SCCCPN Dăbuleni, vol. VIII, Romania, 1994.

[5] Klueva N.Y., Marmiroli E., Nguyen H.T., Mechanism of thermotolerance in crops. In Crop Responses and Adaptation to Temperature Stress. Basra A.S. edit. Food Products Press, Binghampton, New York, 2001.

[6] Rabinowitch H. D., Ben David B., Friedmann M., Light is essential for sunscald induction in cucumber and pepper fruits, whereas heat conditioning provides protection, Scientia Hortic. 29, 21 – 30, 1986.

[7] Rabinowitch H. D., Sklan D., Superoxide dismutase activity in ripening cucumber and pepper fruits, Physiol. Plant. 52: 380 – 384, 1981.

[8] Zoran S. Ilić, Lidija Milenković, Ljubomir Šunić, Saša barać, Jasna Mastilović, Žarko Kevrešan, Elazar Fallik, Effect of shading by coloured nets on yield and fruit quality of sweet pepper, Zemdirbyste-Agriculture, vol. 104, No. 1 (2017), p. 53–62, 2017.