BIOCHEMICAL PARAMETERS OF TOMATO UNDER CHEMICAL FERTILIZERS

INFLUENȚA FERTILIZĂRII CHIMICE LA TOMATE ASUPRA UNOR INDICATORI BIOCHIMICI

STOLERU V. [1*]***, MIHALACHE G.*** [1, 2]***, PERES C.*** [1]***, TELIBAN G.*** [1]***, COJOCARU A.*** [1]***, MURARU V.M.*** [3]

*Corresponding author e-mail: vstoleru@uaiasi.ro

Abstract. *Fertilizers play an important role in providing nutrients to plants and in sustaining an optimal crop yield. In general, plants need three major elements for their optimal growth and development: nitrogen (N), phosphorus (P) and potassium (K). Most of the modern chemical fertilizers contain one or all of these nutrients. Other important elements are sulphur, magnesium and calcium. Micronutrients such as iron, chlorine, copper, manganese, zinc, molybdenum and boron are needed just in small amounts, but are equally important for the plants. In this context, at the UASVM Iasi was organized an experiment to obtain important information regarding the effects of chemical nutrients on tomato biochemical indicators.The water content, the minerals and the tannin content from fruits varied under different chemical fertilizers.*

Key words: chemical fertilizers, tomato, biochemical parameters

Rezumat. *Fertilizatorii joacă un rol esențial în furnizarea de nutrienți pentru plante şi în obținerea unei producții optime. În general, plantele au nevoie de trei elemente principale pentru creştere şi dezvoltare: azot (N), fosfor (P) şi potasiu (K). Majoritatea îngrăşămintelor chimice moderne conțin unul sau toți aceşti nutrienți. Alte elemente importante sunt sulful, magneziul şi calciul. Micronutrienții precum fierul, clorul, cuprul, manganul, zincul, molibdenul şi borul sunt necesari doar în cantități mici. În acest context, au fost testate efectele fertilizării chimice asupra unor indicatori biochimici la plantele de tomate. Rezultatele au variat în funcție de tratamentul chimic aplicat.*

Cuvinte cheie: fertilizare chimică, tomate, indicatori biochimici

INTRODUCTION

Vegetables in general and tomatoes in particular, have specific nutrient consumption, which differs depending on the planned commercial production or the biological production according to the growth and development phenophases. During the vegetation period, the highest consumption of macro- and

[1]University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

[2] Integrated Center of Environmental Science Studies in the North East Region (CERNESIM), The "Alexandru Ioan Cuza" University of Iasi, Romania

[3] National Institute of Research – Development for Machines and Installations Designed to Agriculture and Food Industry – INMA Bucharest**,** Romania

microelements occur in the fruiting stage, when the need for nutrients is double or even triple. For an optimal growth and development, tomatoes take from soil or from different substrates high amounts of macroelements (N, P, K, Ca, Mg and S) and microelements (Fe, Zn, Mn, Cu, B and Mo). The nutrient content in the leaves of tomato plants is closely related to the process of photosynthesis and the production of edible parts.

MATERIAL AND METHOD

Tomato seeds were initially germinated in a growth chamber, under controlled conditions (22°C, 75% relative humidity, 10 h - light, 10.000 Lux). At the appearance of the first two leaves, the tomato seedlings were transferred into 400 cm^3 plastic pots, using Kekkila peat as substrate. Once the plants were 21 days old, they were moved to the experimental greenhouse of "Ion Ionescu de la Brad" University of Agronomy and Veterinary Medicine, Iaşi, under similar conditions to those in the growth chamber. At 42 days, the plants were transplanted into 12 L plastic pots, using the same substrate and 10 different fertilization treatments consisting of solutions with macroelements ($MgSO_4$, KNO_3, K_2SO_4, Ca $(NO_3)_2$, KH_2PO_4, KCl) and a treatment with microelements (Na_2MoO_4, $Na_2[B_4O_5(OH)_4]$]•$8H_2O$, Cu, Mn, Zn, Fe) were applied. The treatments with macroelements used in the experiment were the following: (1) $MgSO_4$, (2) KNO_3, (3) K_2SO_4, (4) Ca $(NO_3)_2$,(5) KH_2PO_4, (6) KCl, (7) $MgSO_4$ + KNO_3 + KH_2PO_4, (8) K_2SO_4 + Ca $(NO_3)_2$ + KCl, (9) the mixture between the 6 macro-elements and (10) one macro-element/day. The proportion of the elements used in the mixture was 1:1. For each plant an amount of 30 ml/solution/day was applied for 21 days along with 0.5 - 1 L of water/day, depending on the phenological phase. The microelements were applied foliarly to all the fertilized plants, in a concentration of 0.02 g/plant/week. For control plants (V11), the macroelement solution was replaced with water, and the microelements were not applied.

Water content

The water content of the samples was determined according to AOAC, 2000, at 105 °C.

Mineral content

The content of iron, calcium, magnesium and zinc was determined by atomic absorption spectrometry according to the methods described in AOAC, 2003.

Tannins content

An amount of 2 g of sample was transferred into 50 ml of distilled water. The resulting mixture was heated to 60°C and then filtered. A volume of 10 ml of 4% copper acetate solution was added to the hot filtrate, which was then boiled for 10 minutes. The resulted precipitate was filtered, dried with filter paper and transferred to a previously weighed crucible. The precipitate was then weighed, incinerated in an oven at 550°C, cooled in the desiccators and then weighted again. The difference between the weight of the sample before and after incineration represents the content of tannins.

RESULTS AND DISCUSSIONS

The water content of the tomato fruits varied along with the fertilization treatment. Therefore, it was observed that the highest water content was recorded for the tomato fruits fertilized with $MgSO_4$ + KNO_3 + KH_2PO_4 + K_2SO_4 + Ca $(NO_3)_2$ + KCl (V9) - 93.62%, followed by those treated with KNO_3 (V2) - 93.58% and by those whose treatment was done with KH_2PO_4 (V5) - 93.51% (fig.1). The smallest water content was registered for the tomato fruits fertilized with K_2SO_4 (V3) - 92.33%. The water content of tomato fruits treated with: the mix consisting of $MgSO_4$, KNO_3, KH_2PO_4, K_2SO_4, $Ca(NO_3)_2$ and KCl (V9), KNO_3 (V2), KH_2PO_4 (V5), $MgSO_4$ + KNO_3 + KH_2PO_4 (V7), the daily cyclic treatment with each macroelement (V10) and $Ca(NO_3)_2$ (V4) was significantly higher than the water content of the fruits of the untreated plants (V11) (fig.1). For the rest of the treatments (V1, V3, V6, V8), the water content of the fruits was significantly lower compared to that of the fruits of the control plants (V11) (fig.1).

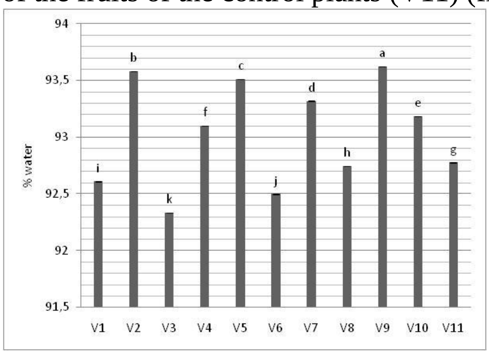

Fig.1 Water content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

The mineral content of the tomato fruits was influenced by the type of fertilization used in the experiment. The highest iron content was recorded for the unfertilized tomato fruits (V11) and those fertilized daily with one macroelement, in a cyclical treatment (V10). The amount of iron registered was 0.051 mg/100 g dry matter and 0.048 mg/100 g respectively. Significantly smaller amounts of iron were recorded for the rest of the treated tomato fruits as compared to those mentioned above. The minimum iron amount was recorded for the fruits of the tomato plants fertilized with $MgSO_4$ (V1), namely 0.01 mg/100 g dry matter. No significant differences among the iron content were observed between the tomato fruits of V5, V6, V7,V8 and V9; V3 – V7; V2, V3 and V4, also between V1 and V2 treatments (fig.2).

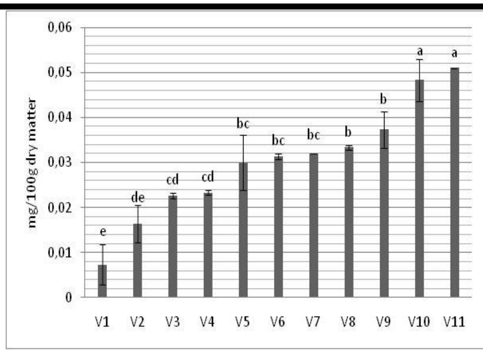

Fig.2 Iron content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

In terms of calcium content, it varied between 8.18 mg/100 g dry matter and 8.15 mg/100 g dry matter. The maximum amount of calcium was recorded for the tomato fruits of the plants fertilized with $MgSO_4$ (V1), while the minimum content was for those of the plants which were included in a daily cyclic treatment with each macroelement (V10) and the tomato fruits of the untreated plants (V11). The amount of the calcium in the tomato fruits of V1 was significant bigger as compared with that registered for the rest of the treatments. Significant differences were also observed between V2 or V3 and V4-V11.The calcium content of the tomato fruits fertilized with the mix of $MgSO_4$ + KNO_3 + KH_2PO_4 + K_2SO_4 + $Ca(NO_3)_2$ + KCl (V9), K_2SO_4 + $Ca(NO_3)_2$ + KCl (V8) and $MgSO_4$ + KNO_3 + KH_2PO_4 (V7) did not differ in significantly way as compared with V6, V10 and V11 (Fig.3). Also, no significant differences were seen between the calcium content of the tomato fruits of V2 and V3, V4 and V5.

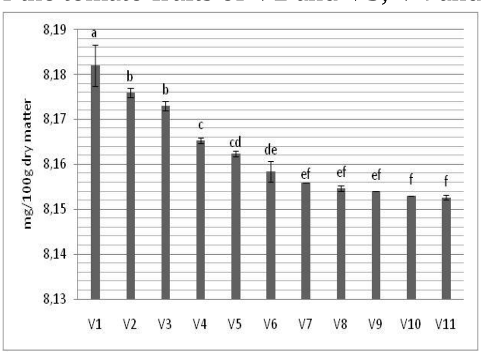

Fig.3 Calcium content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

The magnesium content of the tomato fruits, as in the case of iron, was maximum for the unfertilized plants - V11, but also for those daily fertilized with each macroelement - V10 (2.95 mg/100g dry matter). The lowest magnesium content was of 2.91 mg/100g dry matter registered for the tomatoes treated with $MgSO_4$ (V1). The content obtained for V10 and V11 were significantly higher than that recorded for the rest of the treatments. No significant differences were observed between V2, V3 and V4; V6, V7 and V8, respectively V5, V6 and V7 (fig.4).

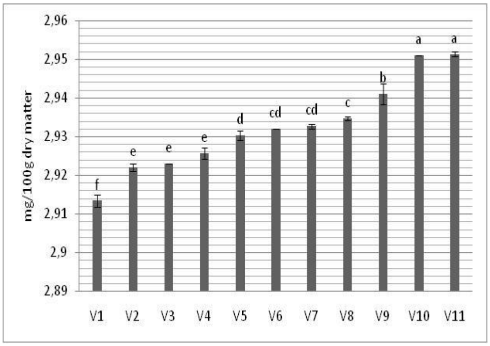

Fig.4 Magnesium content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

Finally, the zinc content of tomatoes fruits fertilized with KCl (V6), the mixtures consisting of: $MgSO_4$ + KNO_3 + KH_2PO_4 (V7); K_2SO_4 + $Ca(NO_3)_2$ + KCl (V8); $MgSO_4$ + KNO_3 + KH_2PO_4 + K_2SO_4 + $Ca(NO_3)_2$+ KCl), the daily cyclic treatment with each macroelement (V11) and the unfertilized plants (V11) was significantly higher as compared to V1-V4 treatments (fig.5).

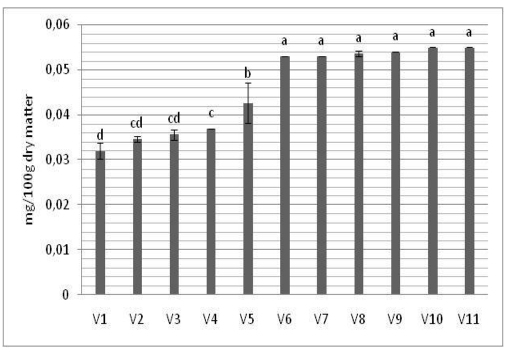

Fig.5 Zinc content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

As in the case of water and minerals content, the tannins content varied depending on the fertilization treatment. The highest amount of tannins was recorded in the fruit of untreated tomatoes (V11), but also in those treated with K_2SO_4 (V3), between which no significant differences were registered (0.34 g/100g fresh matter), followed by those treated with KCl (V6) - 0.33 g/100g fresh matter). The minimum content recorded was for the plants treated with KNO_3

(V2) - 0.28 g/100g fresh matter, followed by those fertilized with KH_2PO_4 (V5) and those with the mix $MgSO_4 + KNO_3 + KH_2PO_4 + K_2SO_4 + Ca(NO_3)_2 + KCl$ (V9) - 0.29 g/100g fresh matter (fig.6).

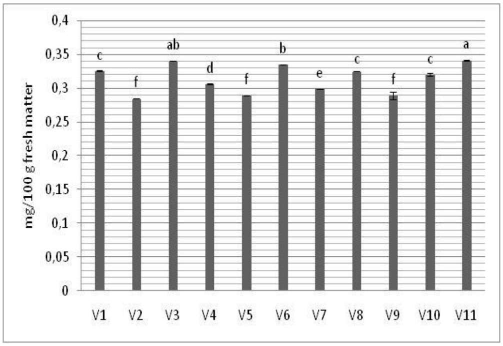

Fig.6 Tannin content in tomato fruits of cv Brillant F1 under the influence of different fertilization treatments. Different letters mean significant differences between variants according to the Tukey test ($p \leq 0.5$).

CONCLUSIONS

1. The tested biochemical parameters of the tomato fruits from cv Brillant F1 plants are highly influenced by the chemical fertilization treatments.

2. The mineral content of the tomato fruits varied according to the analyzed mineral and the fertilization treatment.

***Acknowledgments**: This work was supported by the CNCS-UEFISCDI, PN III PCCDI 41/2018 project.*

REFERENCES

1. **Lacatusu R., 2006 –** *Metoda pentru aprecierea vulnerabilitatii solurilor la impactul agentilor chimici* – Lucr. Simp. St. Univ. “Al. I. Cuza” Iasi-Fac. Geografie, vol. V, serienoua, pag. 23-28.
2. **Maffei M, Bossi S., 2006 -** *Electrophysiology and plant responses to biotic stress***.** In: Volkov AG, editor. Plant electrophysiology – theory & methods. Berlin, Heidelberg: Springer-Verlag;. p. 461–81.
3. **Stoleru V., Filipov F., Stan N., Munteanu N., Stoleru Carmen, 2006 -** *The compost effect on some stagnic hortic luvisols characteristics cultivated with vegetable in ecological system.* Lucrări ştiințifice vol.49, Horticultură, UŞAMV Iaşi, pg. 1045-1050.
4. **Wang Z.Y., Leng Q., Huang L., Zhao L.L., Xu Z.L., Hou R.F., Wang C., 2009 -** *Monitoring system for electrical signals in plants in the greenhouse and its applications,* Biosystems Engineering, 103(1), 1-11, 2009.
5. **Munteanu N., Bireescu L., Bulgariu D., Calin M., Hura C., Stoleru V., 2011 –** *Flux tehnologic optimizat in legumicultura ecologica pentru siguranta alimentara si sustenabilitate.* Editura Ion ionescu de la Brad Iaşi. ISBN: 978-973-147-095-5.
6. **Caruso G., Stoleru V., Munteanu N., Sellitto V.M., Teliban G.C., Burducea M., Tenu I., Morano G., Butnariu M., 2019 -** *Quality Performances of Sweet Pepper under Farming Management.* Not Bot Horti Agrobo, 47(1).