COMPARATIVE STUDY ON THE BIOMETRIC PARAMETERS OF TOMATO SEEDLINGS PRODUCED BY USING ENVIRONMENTALLY FRIENDLY METHODS

ULEANU Florina, GHIORGHE Cristina, VULPE Mădălina, BĂDULESCU Adriana, OPREA Mihaela

Abstract. The purpose of this study is to obtain seedlings using new technologies that have a positive effect on the limitation of pollutants, using natural fertilizers, aquarium water, poultry manure, manure, both to stimulate the growth, development and protection of seedlings, and for early harvesting. Through the proposed objectives, basic, strategic and applied research is being promoted and supported for the protection of natural resources (water, soil, and climate) in order to increase the quantity and quality of vegetable production. It proposes a new, cost-effective and competitive technology that focuses on food safety and sustainability. The biological material was represented by Rila F1 tomatoes. We made 4 experimental variants, of which a control variant, fertilized only once with ammonium nitrate in the amount of 30 g / seedlings, a method commonly used in seedlings obtaining. In the other 3 variants we used natural fertilizers to stimulate tomato seedlings, so for variant 2 we used aquarium water as a natural fertilizer, for variant 3 we used a 1:10 dilution of poultry manure, and for variant 4 we used cow manure. Before planting the seedlings, measurements were made regarding their height, the length, weight and volume of the roots, the volume and weight of the aerial part of the plant, the total volume and weight of the seedlings. Statistical analysis using the ANOVA program using the Duncan multiple comparisons test ($P \leq 0.05$) showed that there are no significant differences between the four variants taken into consideration regarding the studied characters except those related to the aerial part. The highest value of the weight of the aerial part was recorded in the case of V4 (fertilized with cow manure) and a significantly lower value in V2 (fertilized with aquarium water). The V3 variant (fertilized with poultry manure) also recorded a higher leaf weight value compared to V1 (fertilized with ammonium nitrate). Compared to V2, the values obtained are significantly higher. Regarding the volume of the aerial part we noticed a significant difference between the V4 and V2 variants. In the case of V1 and V3, the differences are not significant.

Keywords: seedling, tomato, aquarium water, poultry manure, manure.

Rezumat. Studiu comparativ al parametrilor biometrici la răsaduri de tomate produse prin utilizarea metodelor prietenoase de mediu. Scopul prezentului studiu este obținerea unor răsaduri utilizând noi tehnologii cu efect pozitiv asupra limitării agenților poluanți, utilizând fertilizanți naturali, apă de acvariu, gunoi de păsări, mraniță, atât pentru stimularea creșterii, dezvoltării și protecției răsadurilor, cât și pentru o timpurietate a recoltelor. Prin obiectivele propuse se promovează şi se susţin cercetări de bază, strategice şi aplicative pentru protecţia resurselor naturale (apa, sol, clima) în scopul creşterii cantitative şi calitative a producţiei legumicole. Se propune o nouă tehnologie, rentabilă şi competitivă ce vizează siguranţa alimentară şi sustenabilitatea. Materialul biologic a fost reprezentat de tomate Rila F1. Am realizat 4 variante experimentale, dintre care o variantă martor, fertilizată o singură dată cu azotat de amoniu în cantitate de 30 g/răsad, metodă folosită în mod frecvent în obținerea răsadurilor. În celelalte 3 variante am folosit fertilizanți naturali pentru stimularea răsadurilor de tomate, astfel că pentru varianta 2 am folosit ca îngrășământ natural apa de acvariu, pentru varianta a 3-a am utilizat o diluție de 1:10 a gunoiului de păsări, iar pentru varianta 4 am folosit mraniță. Înainte de plantarea rasadurilor au fost efectuate măsurători cu privire la înălțimea acestora, lungimea, greutatea și volumul rădăcinilor, volumul și greutatea aparatului foliar, volumul și greutatea totală a răsadurilor. Analiza statistică realizată cu ajutorul programul ANOVA folosind testul comparațiilor multiple Duncan ($P \leq 0.05$) a arătat că nu există diferențe semnificative între cele patru variante luate în lucru în ceea ce privește caracterele studiate exceptând cele legate de aparatului foliar. Cea mai mare valoarea greutății aparatului foliar am înregistrat-o în cazul lui V4 (fertilizată cu gunoi de grajd) și o valoare semnificativ mai mică la V2 (fertilizată cu apă de acvariu). Varianta V3 (fertilizată cu gunoi de pasăre) a înregistrat, de asemenea, o valoare mai mare a greutății foliare comparativ cu V1 (fertilizat cu azotat de amoniu). Comparativ cu varianta V2 valorile obținute sunt semnificativ mai mari. În ceea ce privește volumul aparatului foliar am observat o diferență semificativă între varianta V4 și V2. În cazul variantelor V1 și V3 diferentele nu sunt semnificative.

Cuvinte cheie: răsad, tomate, apă de acvariu, gunoi de păsări, mraniță.

INTRODUCTION

Seedlings can be defined as young leguminous plants grown in greenhouses, solariums, ponds, shelters or unprotected land and which, when conditions permit, are planted permanently in protected or open field (POPESCU & ANASTASIU, 2010). Quality indices for tomato seedlings are: 15-20 cm height, 6-8 leaves, dark green colour (POPESCU & HOZA, 2000).

As defined by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO), in Codex Alimentarius organic farming is a "full production management system that contributes to supporting and strengthening agricultural ecosystem resistance, including biodiversity, biological cycles and soil biological activity" (www.fao.org). The principles of organic farming refer to: maintaining soil fertility, protecting the environment, respecting consumer health, global vision of interactions in nature, farm-a unit, an equilibrium organism (DEJEU et al., 1997; TONCEA & STOIANOV, 2002).

Conventional agriculture put the humanity at risk through the degradation of agricultural ecosystems, by resource depletion, environmental pollution and crops, and so on. In this sense, the moves to promote ecological agriculture (organic, biological), also called unconventional agriculture, with low input, clean and unpolluted, began to

be stated more impetuously (BIREESCU, 2011). The positive evolution of certified organic areas in Romania demonstrates the growing interest of bio-farmers.

Tomato crops need a large amount of fertilizers to achieve considerable yields. To enhance growth and plant development, fertilizer organic and inorganic use is essential (C. SPLITTSTOESSER, 1990). For improving plant growth and development, use of organic and inorganic or fertilizer is essential (C. SPLITTSTOESSER, 1990). The common organic matters used in agriculture are manures and composts, which have different composition of nutrients (i.e., nitrogen, phosphorous, potassium, sulphur, zinc, iron, etc. (ALI et al., 2015).

There is an urgent need for revisiting the concept of fertilizers, to reduce its environmental footprint while making them more economically efficient for resource-poor farmers. The recycling of nutrients from waste water, manure and offal reduces overall losses and helps to recapture nutrients for plant uptake. Such organic fertilizers contain macro- and micro-nutrients, which may provide added value, compared to standard mineral fertilizers (BINDRABAN et al., 2015). An aquaponic system as the growth environment is suitable for both fish and for the nitrification process which produces the necessary nutrients for plant growth (RADU et al., 2016). Poultry manure increased the number of leaves, plant height, leaf area, number of fruits and fruit weight significantly in Owo, the forest- savanna transition zone in southwest Nigeria (OLASEKAN & TAIWO, 2009).

The chicken manure had a significant effect on the plant height and root length of Isabella F1tomatoes, on the leaf area of sun cherries, on the fresh and dry weight of the root of Lelord, on the fresh and dry weight of the leaves of Sadia F1. On the other hand, the fresh and dry weight of the shoots of the Isabella tomato variety was increased when treated with mixed manure. Agro fish pellet treatment had increased the stem diameter of Isabella F1 significantly (KALBANI et al., 2016).

This paper was made as a comparative study of the methods to obtain tomato seedlings (using natural fertilizers, aquarium water, poultry manure, and manure) in small, medium and big farms. The purpose of this study is the prominence of the differences between environmentally friendly methods to obtain tomato seedlings for a protected culture.

MATERIAL AND METHODS

For the realization of the experiment we used *Lycopersicon esculentum* Mill seeds, Rila F1 variety, which is an undetermined early hybrid for production in protected areas (greenhouses, solariums) and in the field. The plant presents resistance to the tomato mosaic virus, *Verticilium*, fusariosis and nematodes. The fruits have 180-200 g, are round, smooth, hard, without a green cap. Cultivation takes place at a distance of 80/35 cm, with 6-8 clusters.

We sowed the seeds on February 24 in a peat-based professional nutrient substrate, Klasman TS3, pH 5,5-6,5, with black peat 20%, 80% blonde peat and microelements, in alveolar trays with 32 cells in order to eliminate plant stress, knowing that a stressed body is more sensitive to pathogens. We sowed 5 seeds on the cell, and then we reduced them according to the vigour and health of the plants, so that there was only one plant / cell at the end.

We applied maintenance work during the vegetation period uniformly to all studied variants. We applied specific agricultural techniques to seedling production: daily ventilation, watering with warm water using a sprinkler with a fine sieve, a chemical fertilizer / natural products according to the experimental variant, weeds were removed as often as necessary. All these factors operate in close correlation, and each of them reaches maximum efficiency only if they are all covered. We studied 4 experimental variants, in 3 repetitions of 10 plants. We applied chemical fertilizers-ammonium nitrate (once 30 g/plant – a method frequently used to obtain seedlings) /natural products (once every seven days, with 150 ml of aquarium water / plant or poultry manure 150 ml / plant or 100 g cow manure / plant) (Table 1).

Table 1. Experimental variants.

Experimental variants	Used fertilizers
V.1	control (ammonium nitrate) 30 g/plant
V.2	aquarium water 150 ml/plant
V.3	poultry manure (1:10) 150 ml/plant
V.4	cow manure 100 g/plant

Before planting the seedlings we made various observations and determinations regarding the effect of bio fertilizers on the growth and development of seedlings by direct measurements, determining the following parameters: plant height increase, the length of the roots, roots volume, the volume of the aerial part of the seedling, total volume, the weight of the aerial part of the seedling, the weight of the roots, and total weight. We performed statistical analysis using the ANOVA program in SPSS 16.0 software using the Duncan multiple comparisons test ($P \leq 0.05$). We expressed the results of this study as mediums.

RESULTS AND DISCUSSIONS

The seedlings responded quite differently to fertilization variants. High values were obtained regarding the height of the seedlings compared to the values reported in the literature, indicating that the optimal seedling planting period has been exceeded (Table 2).

Table 2. Quality indices for tomato seedlings (POPESCU & HOZA, 2000).

Species	Height (cm)	Number of leaves	The diameter at the parcel (mm)	Age (days)	Color
Tomato	15-20	6-8	6-8	90	Dark green

From the data presented in Fig. 1, we can see a maximum value of the seedlings' height increase for the V3 variant (poultry manure fertilization) compared to the V1 variant (produced according to classical technology). All the studied variants exceeded variant V1 (fertilization with ammonium nitrate). OLASEKAN & TAIWO also showed in 2009 a more intense increase in height in the case of seedlings fertilized with manure. A statistical analysis of the data showed that the obtained values are different, but the differences are not significant.

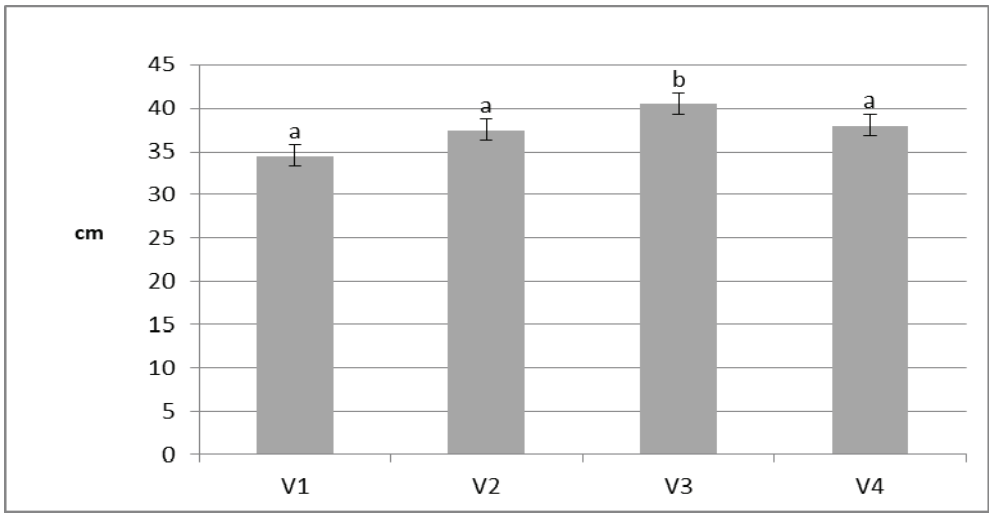

Figure 1. Increase in height of Rila F1 tomato seedlings naturally fertilized (cm).

Regarding the length of the root system in Fig. 2, we observed the highest value for variant V4 (fertilization with cow manure), the only one that exceeded the control variant. The lowest value was recorded for variant V2 (aquarium water fertilization). The plant roots for V1 and V3 variants are slightly larger compared to the control, but the average differences are not significant ($p > 0.05$). The increase in vegetative growth might be due to higher availability of nitrogen, which ultimately increased the vegetative growth. Similar results were obtained by BROWN (1995) who reported that the application of organic and inorganic fertilizer might have resulted in an increase in the vegetative growth and induced more number of leaves in tomato plants.

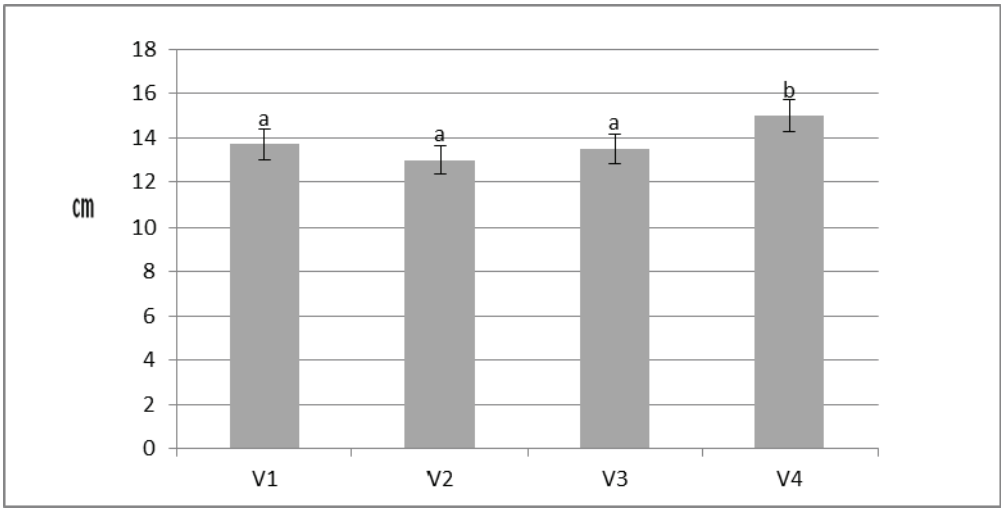

Figure 2. The length of the root system of naturally fertilized Rila F1 tomato seedlings (cm).

From the data presented in Fig. 3, we can see the highest weight of the aerial part in the V4 variant (fertilized with manure) and a significantly lower value at V2 (fertilized with aquarium water). Despite the potential benefits, organic fertilizers may be unbalanced in terms of relative availability of nutrients (BINDRABAN et al., 2015). The variant V3 (fertilized with poultry manure) also recorded a higher value of foliar weight compared to V1 (fertilized with ammonium nitrate). Compared with V2, the values obtained are significantly higher.

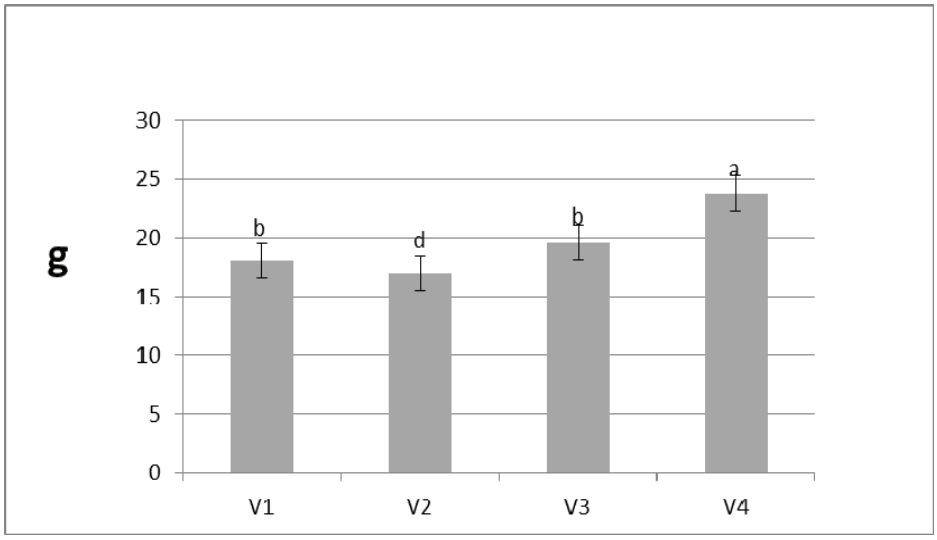

Figure 3. Aerial part weight of Rila F1 tomato seedlings naturally fertilized (g).

All the studied variants exceeded variant V1 (fertilization with ammonium nitrate) in case of the weight of the root system (Fig. 4). Comparing the average values to the four studied variants, we observed significant differences between the V4 variant (6.48 g) and the V1 variant (2.55). Regarding the results obtained on variants V2 and V3, the differences are not significant. Han et al. (2016) didn't observe a synergistic effect of the organic manure and NPK fertilizer on the root system weight on *Liriodendron* young plants. Increased organic matter concentrations in soil have showed to improve soil properties - soil density, soil aeration and enhance the soil water holding capacity for plant growth and root development (ZIA et al., 1998).

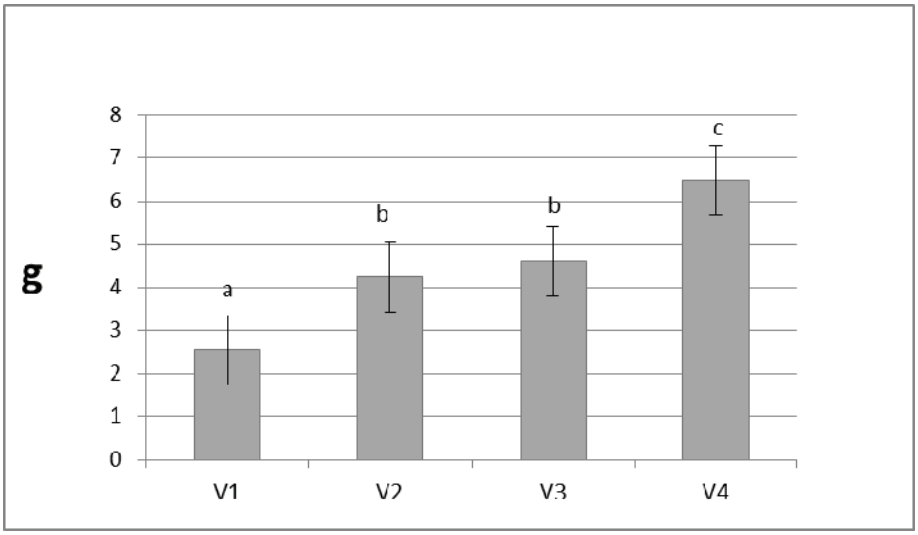

Figure 4. The weight of the root system of naturally fertilized Rila F1 tomato seedlings (g).

Regarding the total weight of the seedlings (Fig. 5), the V4 variant fertilized with cow manure, recorded the highest value. All the studied variants exceeded the variant V1 (fertilization with ammonium nitrate / single dose used for Moisă & Berar (2015) and showed that the application of treatment with poultry manure waste was most effective, since it has enabled the achievement of significant increases from 9.75 to 12.72% in terms of leaves surface, compared to the results associated to the application of Lithovit (MOISĂ & BERAR, 2015).

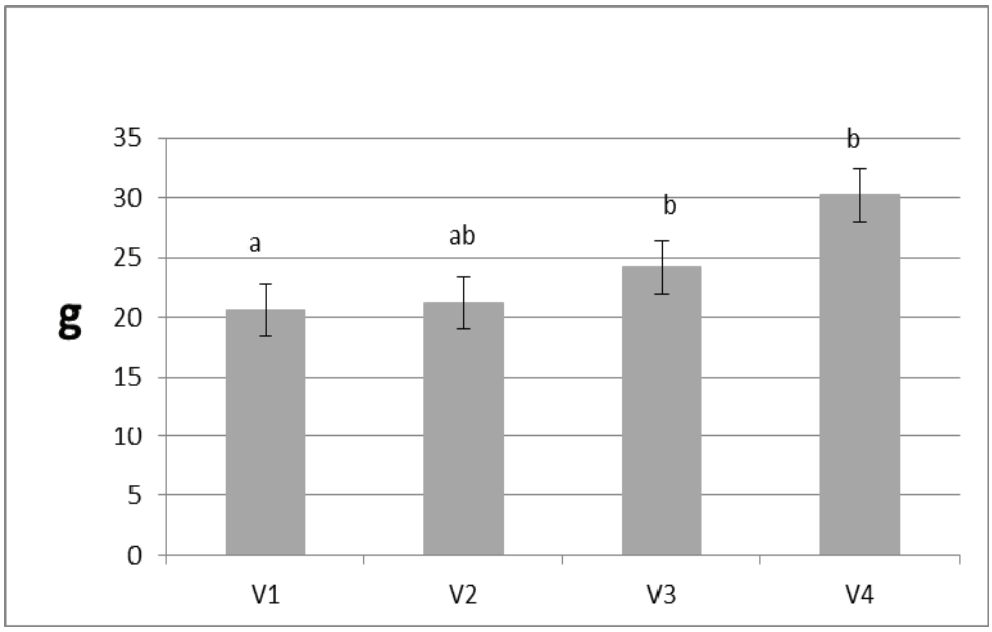

Figure 5. Total weight of naturally fertilized Rila F1 tomato seedlings (g)

Regarding the root system volume, an average of 5 cm^3 was recorded for fertilized aquarium and cow manure variants and an average of 4 cm^3 for those fertilized with poultry manure and ammonium nitrate (Fig. 6). Statistical analysis using the ANOVA program with the Duncan multiple comparisons test ($P \leq 0.05$) showed that there are no significant differences between the four studied variants.

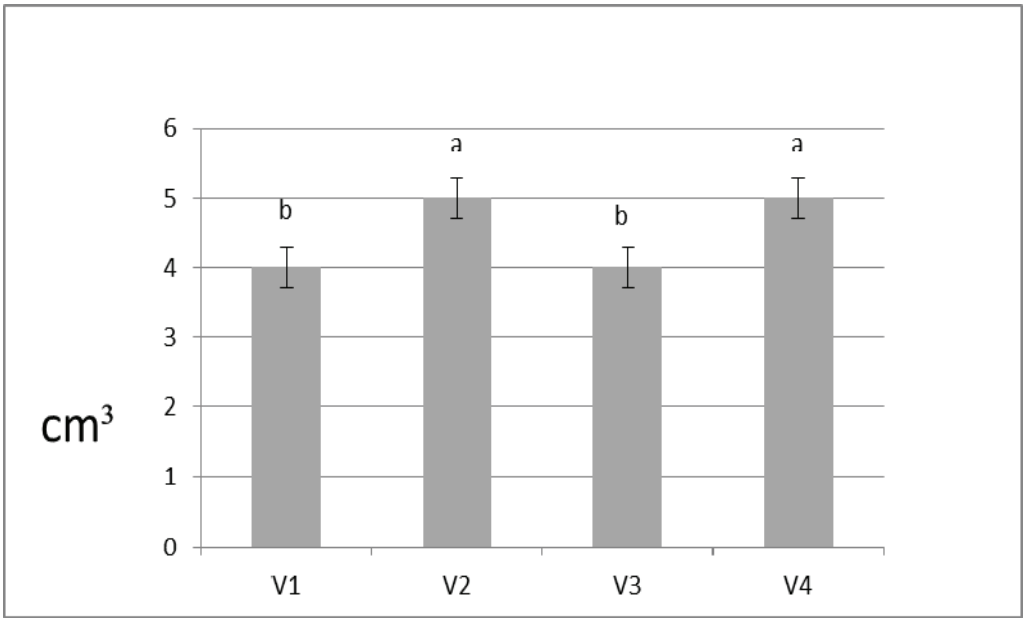

Figure 6. The root system volume of naturally fertilized Rila F1 tomato seedlings (cm^3).

In Fig. 7 we noticed that the highest value of the aerial part volume of Rila F1 tomato seedlings has been recorded for the V4, cow manure. In V2 and V3, the foliar volume values were lower compared to control variant V1. Analysing the significance of the differences resulting from the statistical analysis, we observed a significant difference between variant V4 and V2. In the case of V1 and V3, the differences are not significant. Horse manure with straw, food waste compost and cattle manure proved to be effective organic fertilizers in terms of growth of cucumber seedlings and nutrient supply ability (HAN et al., 2016; RADU et al., 2016; KOVÁCS et al., 2017).

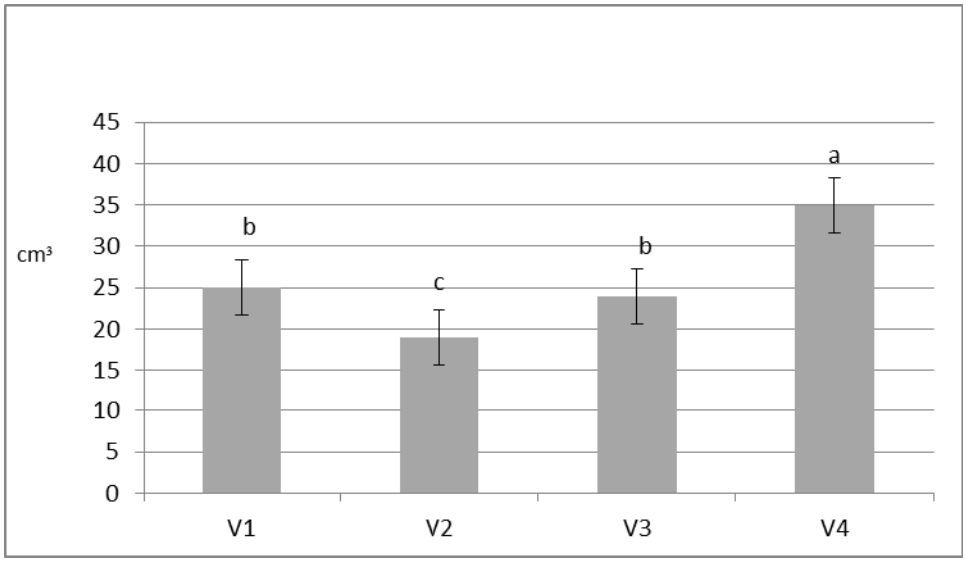

Figure 7. The volume of the aerial part of naturally fertilized Rila F1 tomato seedlings (cm^3).

CONCLUSIONS

Statistical analysis using the ANOVA program using the Duncan multiple comparisons test ($P \leq 0.05$) showed that there are no significant differences between the four variants taken into consideration regarding the studied characters except those related to the aerial part.

The highest value of the weight of the aerial part was recorded in the case of V4 (fertilized with cow manure) and a significantly lower value in V2 (fertilized with aquarium water). The V3 variant (fertilized with poultry manure) also recorded a higher leaf weight value compared to V1 (fertilized with ammonium nitrate). Compared with V2, the values obtained are significantly higher. Regarding the volume of the aerial part we noticed a significant difference between the V4 and V2 variants. In the case of V1 and V3, the differences are not significant.

Due to the fact that the nutrients from natural fertilizers are assimilated more slowly by the plants, they do not cause substantial increases of the studied parameters in the young plants, but only small changes were detected in values compared with the chemical fertilization.

The use of bio fertilizers in the production of Rila F1 tomato seedlings has played an important role in their growth and development through the intake of mineral substances, so that the use of chemical substances in the fertilization of tomato seedlings can be successfully replaced in the production of Rila F1 tomato seedlings with positive results on environmental protection.

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Uleanu Florina, Ghiorghe Cristina, Vulpe Mădălina, Bădulescu Adriana, Oprea Mihaela
University of Piteşti, Str. Târgu din Vale, No. 1, 110040, Piteşti, Romania.
E-mail: uleanuflorina@yahoo.ro

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