

Original Article

## Physiological Indicators Study Involved in Productivity Increasing in Tomato

BEIN AN Carmen<sup>1</sup>, Radu UM LAN<sup>1</sup>, tefania GÂDEA<sup>2</sup>, Sorin VÂTC <sup>2\*</sup>

<sup>1</sup>Banat University of Agricultural Sciences and Veterinary Medicine, Calea Aradului St., No. 119,  
300645 Timi oara, Romania

<sup>2</sup>University of Agricultural Sciences and Veterinary Medicine Cluj - Napoca, M n tur St., No. 3 – 5,  
400327 Cluj-Napoca, Romania

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### Abstract

The research objectives were to study the influence of fertilizers based on carbon dioxide on the main physiological indices involved in developing tomato bio-productivity: plant height (cm); leaf area (cm<sup>2</sup>); total quantity of chlorophyll (SPAD units); photosynthesis intensity (ppm CO<sub>2</sub>); determination of dry matter from leaves (%) and yields per plant (kg). The biological material used was the San Pierre variety from SC Doradda SRL.

*Keywords:* CO<sub>2</sub> fertilizer, photosyntesys, growth, tomato

### 1. Introduction

In addition to the nutrients known, tomatoes contain a compound for medicine respectively lycopene. Numerous medical studies show the direct action of this pigment on free radicals in the human body.

Free radicals are considered very strong oxidative molecules, which attack cell membranes of cells from various tissues of the human body and human and inducing DNA defective replication processes which lead to rapid aging of the organism.

Lycopene is not synthesized by the human body, only way to get this pigment is consuming fruits or vegetables containing pigment in question. The degree of metabolism in the body of this pigment is greater at consumed fresh products than processed ones.

Worldwide, from total quantity of tomatoes produced annually, 80% is marketed in various processing forms and only 20% is consumed fresh.

### 2. Material and Method

San Pierre variety is semi-early with indeterminate growth, suitable for fresh consumption. The plant is tall, vigorous, with round fruit, firm, smooth surface, weighing between 120 and 180 g with intense red color at technical maturity. It is recommended by very pleasant taste, commercially attractive appearance, and good resistance to cracking and transport. In addition, the variety San Pierre has good resistance to specific diseases.

In order to obtain seedlings, seeds were sown in PVC nutritional pots with 7 - 8 cm side length, using a mixture of soil comprising 2 parts peat and one part sandy soil.

In the seedling stage were applied two fertilization with nutrient solution, using the

\* Corresponding author.  
Tel: +40-264-596384  
Fax: +40-264-593792  
e-mail: sorin\_vatca@yahoo.co.uk

solution Knopp [1], were performed necessary watering and maintained plant growth factors. Seedling was planted in vegetation pots with 10 liters capacity in a soil mix consisting of 2 parts soil from field, one part garden soil and one part sandy soil. The research was conducted in the greenhouse of the Plant physiology Unit from the University of Agricultural Sciences and Veterinary Medicine of Banat, Timi oara (UASVMBT) during 2013 - 2014. The setting of phenophases duration was made using the BBCH coding identification system of plant development stages. It has been developed by the specialists of big corporations leading producing pesticides in the world: Bayer (B), BASF (B), Ciba - Geigy (C) and Hoechst (H) - Shering, in order to find a unitary way based on a common language for identifying stage of development in which the plant is found. The coding system is unitary and is available for all plant species, both cultivated and wild [2].

The experiments were carried out in three different development phases BBCH:

- 1.3 - 1.5 (3 - 5 leaf emergence);
- 6.3 - 6.5 (about 30 - 50% of flowering plants);
- 8.7 - 8.9 (full ripening of fruits).

The experimental variants were:  $V_0$  - control (untreated),  $V_1$  - treated with foliar fertilizer 2.3.1,  $V_2$  - treated with Lithovit. The first Lithovit treatment was applied in the development stage 1.2, than are carried out other three treatments at an interval of 28 days between them. The dose administered was 4 g/l L  $H_2O$ . First 2.3.1 fertilizer treatment was made in the development stage 1.4, at the interval of 14 days between treatments. Were carried out 4 treatments with a dose of 15 ml/ L  $H_2O$ . Leaf area ( $cm^2$ ) was determined by the parameters of the leaf. Was measured the length and width of the leaf limb at half the length. Linear parameters are represented by the length and width of leaf or foliole. In order to determine the foliar surface was used the relation:

$$S = L * l * b$$

were:

- S - foliar surface ( $cm^2$ );
- L = length of leaf (cm);
- l = leaf width (cm) and
- b = correction factor.

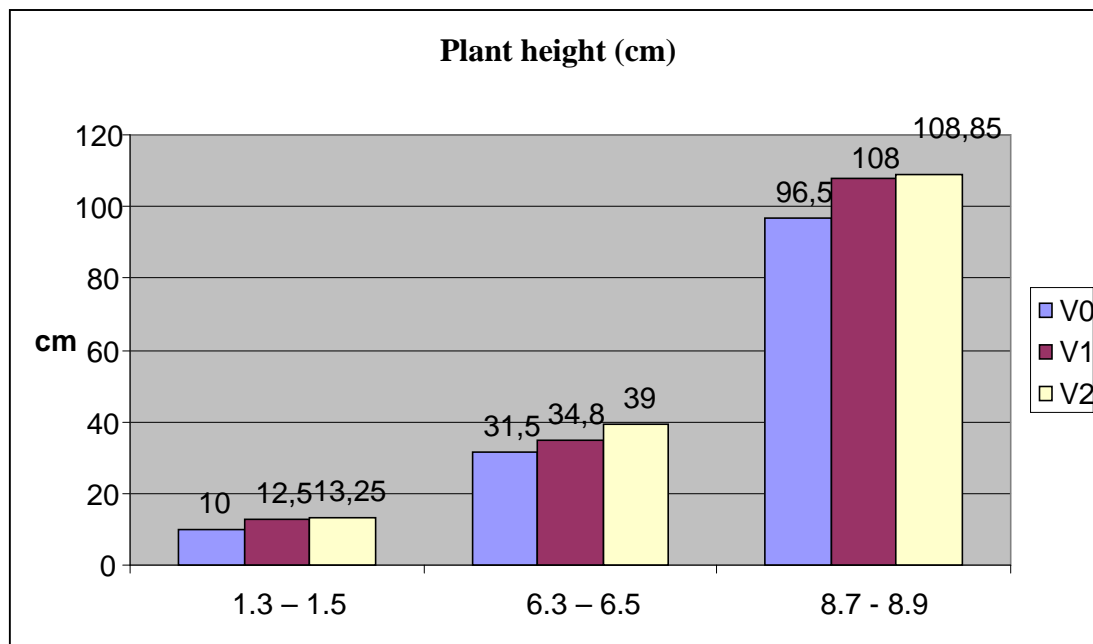
Correction coefficient "b" varies depending on the geometrical shape of the leaf, having in generally, below par values. Also, the correction coefficient may be different within the same species from one genotype to another, depending on the stage of development of the plant is found or differ

from one author to another [2]. Tomatoes correction coefficient is 0.7. Total chlorophyll quantity (SPAD units) from leaves was determined using portable chlorophyll-meter SPAD-502 (single photon avalanche diode). This device determines the relative content of chlorophyll, by measuring the absorbance of a leaf in two wavelength ranges. SPAD-502 measure light leaf absorbance in red light radiation within the IR area. Using this principle, chlorophyll-meter calculates a numerical value which is directly proportional with the amount of chlorophyll from leaf. The photosynthesis process involves the exchange of gases between the leaf and the environment. Leaf takes  $CO_2$  and removes  $O_2$  usually in a ratio of 1:1. If the leaf should be put in a room, the air passing through the room would become depleted in  $CO_2$  and  $O_2$  enriched. By measuring the rate at which these gases are exchanged between the leaves and its environment, the rate of photosynthesis can be determined. Measuring the intensity of photosynthesis through gas exchange method was performed with the device Qubit System for  $CO_2$  analysis with infrared gas analyzer. In this experiment it was demonstrated the importance of  $CO_2$  for photosynthesis and that the intensity of photosynthesis increases with increasing  $CO_2$  concentration in the atmosphere, until reaching saturation point with  $CO_2$ . At that time, the intensity of photosynthesis is limited to the  $CO_2$  fixation processes being caused by insufficient amount of light energy or the velocity, wich enzymes catalyze metabolic reactions of photosynthesis. This difference in  $CO_2$  measurement and flow measurement of gas through the chamber allows to calculate the emission rate of photosynthetic or  $CO_2$  fixation. When determined the amount of  $CO_2$  in the range fixed by the plant measurement (60 minutes), resulted the difference between the initial and final concentration of  $CO_2$ :

$CO_2 = CO_2 \text{ initial} - CO_2 \text{ final}$ . [3] Determination of dry matter percentage from leaves was performed using a thermobalance Kern[4].

### 3. Results and Discussions

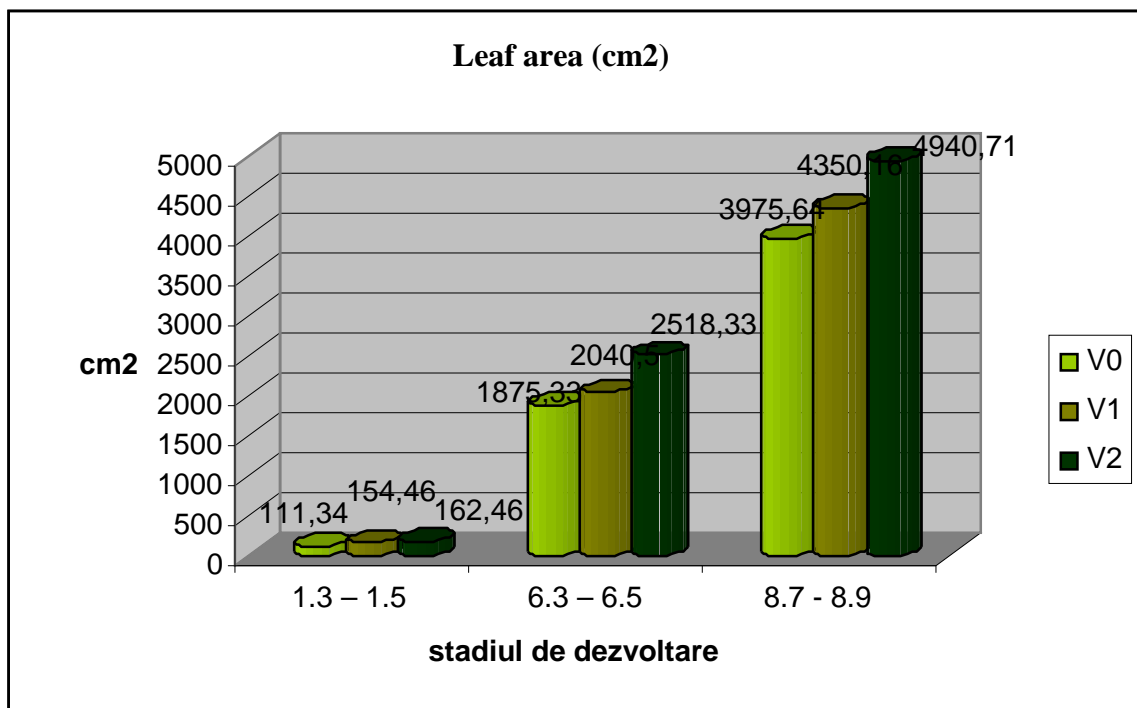
In that concerning plant height there are differences between the three variants in the three stages of development. It can be seen that at the stage 1.3 - 1.5, the smallest size of plants was recorded at  $V_0$  (10 cm) and the highest in  $V_2$  (13.25 cm). In stage 8.7 - 8.9, all version presented the highest waist (108.85 cm), at very close difference by  $V_1$  (108 cm), aspect suggested by Fig. 1.



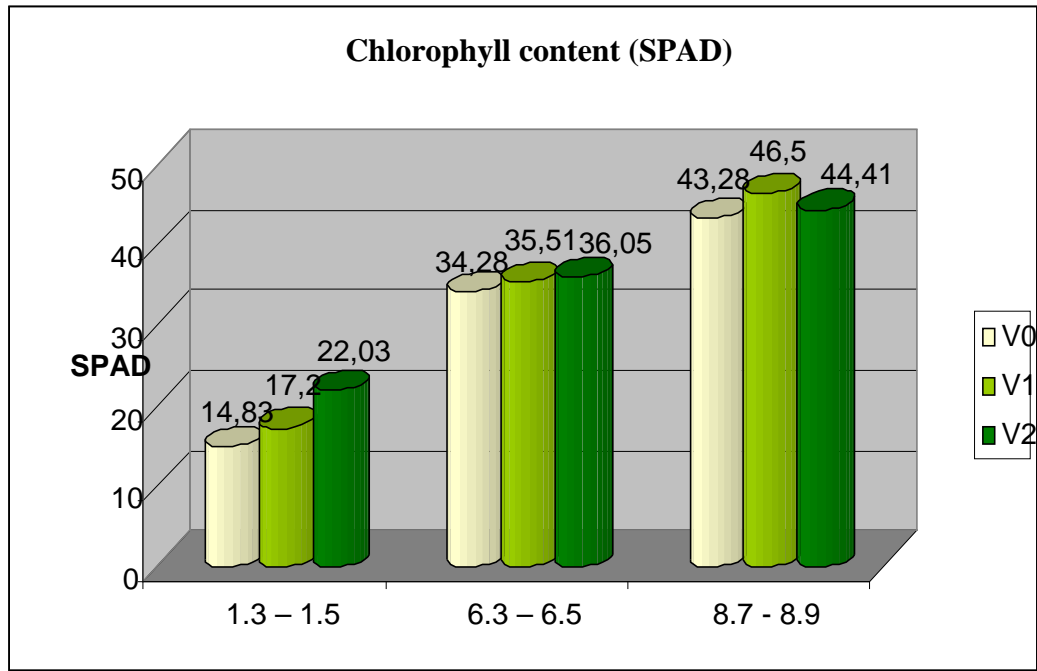
**Figure 1.** Experimental results on plant height (cm) at different stages of development

Regarding leaf area can be seen that in the early stages of development are not significant differences between the three experimental variants studied (Fig. 2). In stage 8.7 - 8.9, variant 2 has achieved the highest leaf area of 4940.71 cm<sup>2</sup>, while the lowest was recorded in 3975 V<sub>0</sub> with 64 cm<sup>2</sup>. As regards the total chlorophyll content in units SPAD, there are significant differences between the three

experimental variants. Thus at the stage 1.3 - 1.5 in untreated variant (V<sub>0</sub>) was recorded the lowest total chlorophyll content (SPAD 14.83), while for variant 2 (22.03 ADP) was recorded a higher content. In stage 8.7 - 8.9, in the case of experimental variant 1 was recorded the highest total chlorophyll content (SPAD 46.5) while for variant 0 (43.28 ADP) was registered a lower content (Fig. 3).



**Figure 2.** Experimental results on leaf area (cm<sup>2</sup>)



**Figure 3.** Experimental results on chlorophyll content (SPAD units) in various stages of development

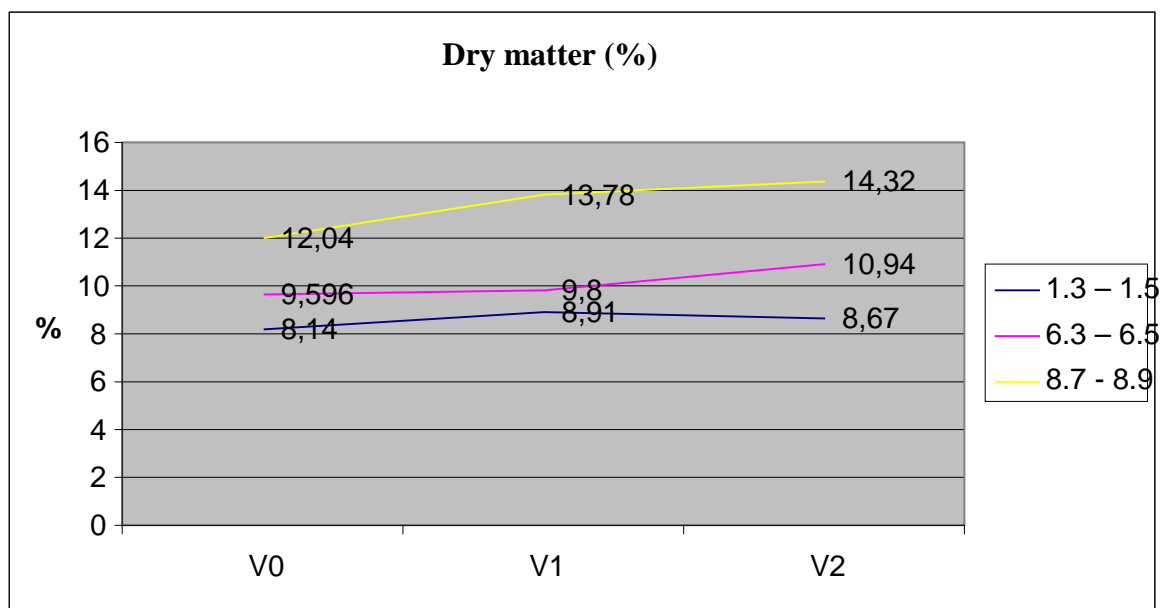
In terms of percentage of dry matter there are no significant differences between in the three versions. At the stage 1.3 - 1.5, the highest value was recorded in variant 1 (8.91%).

However, there are significant differences in stage 8.7-8.9, the highest percentage being in variant 2 - 14.32% (Fig. 4).

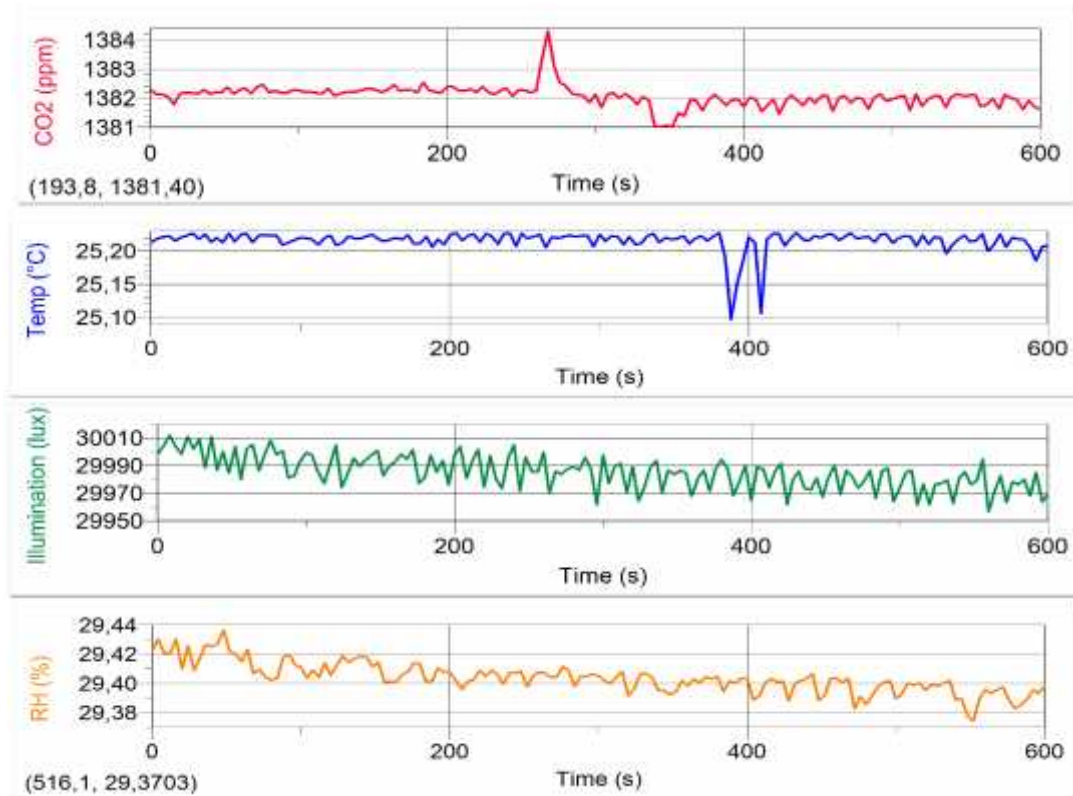
In the case related to the intensity of photosynthesis physiological index was observed

that  $V_0$  has reached a value of 1 ppm  $\text{CO}_2/10$  minutes (6 ppm/hour). On  $V_1$  variant was made 12 ppm/hr, and at the  $V_2$  - 24 ppm  $\text{CO}_2$  /hour (Figs. 5, 6 and 7).

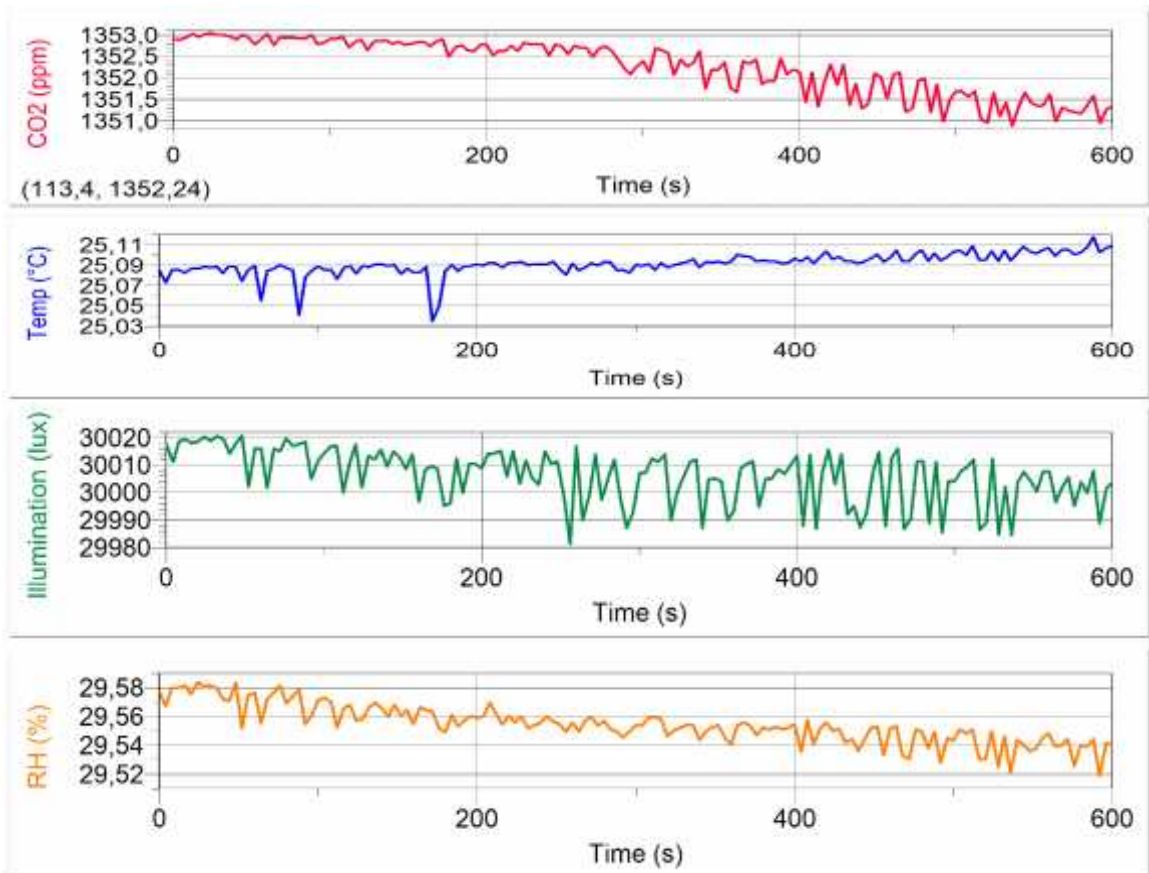
The highest photosynthesis intensity was observed in variant  $V_2$  treated with Lithovit foliar fertilizer based on  $\text{CO}_2$ . Inside leaves the particles of Lithovit are decompose and release, among other substances, particularly  $\text{CO}_2$ .



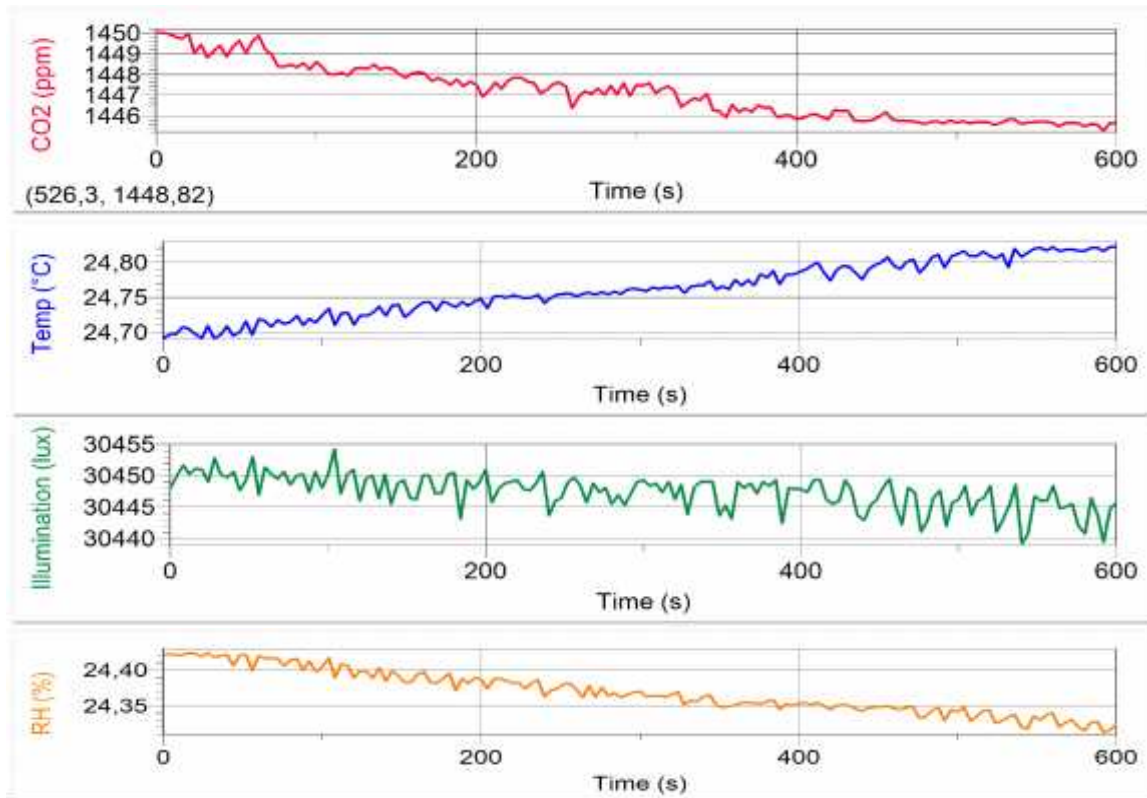
**Figure 4.** Experimental results on the dry matter content (%) in different stages of development



**Figure 5.** Experimental results concerning the intensity of of photosynthesis (ppm CO<sub>2</sub>) at V<sub>0</sub>; Initial CO<sub>2</sub> - 1382.5 ppm; Finally CO<sub>2</sub> -1381.5 ppm ; CO<sub>2</sub> = 1 ppm/10 min.

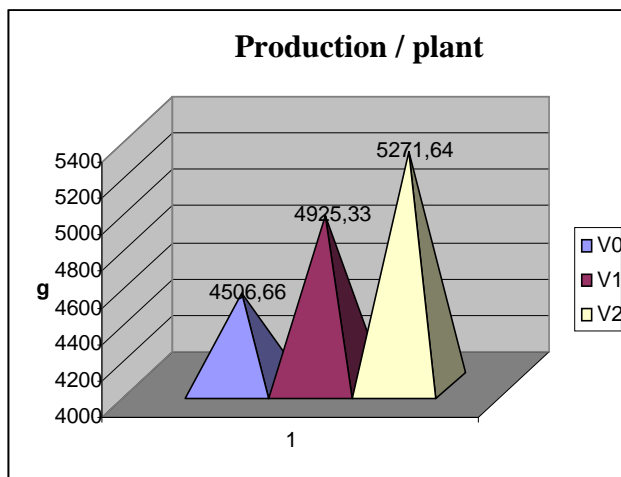


**Figure 6.** Experimental results concerning the intensity of of photosynthesis (ppm CO<sub>2</sub>) at V<sub>1</sub>; Initial CO<sub>2</sub> - 1353 ppm; Finally CO<sub>2</sub> -1351 ppm ; CO<sub>2</sub> = 2 ppm/10 min



**Figure 7.** Experimental results concerning the intensity of of photosynthesis (ppm CO<sub>2</sub>) at V<sub>2</sub>; Initial CO<sub>2</sub> - 1450 ppm; Finally CO<sub>2</sub> - 1446 ppm ; CO<sub>2</sub> = 4 ppm /10 min.

Lithovit fertilizer particles, finely sprayed on the leaf surface are absorbed and transformed in CO<sub>2</sub>. Therefore, Lithovit fertilizer can significantly enhance photosynthesis because the external factor that limiting photosynthesis is the natural content of CO<sub>2</sub> in the air. Concerning the production per plant was observed that variant 2 has the highest production of 5271.64 g compared with the control variant, 4506.66 g (Fig. 8).



**Figure 8.** Experimental results on the production/plant (g)

Variant 1 has achieved the production rather close to V<sub>2</sub> (4925.33 g)

#### 4. Conclusions

- Concerning plant height there are differences between the three variants in the three stages of development. It can be seen that in stage 1.3 - 1.5, the smallest size of plants was recorded at V<sub>0</sub>, and the highest in V<sub>2</sub>. In stage 8.7 - 8.9, variant V<sub>2</sub> presented also the highest waist, very close to V<sub>1</sub>.
- Regarding leaf area can be seen that in the early stages of development were not significant differences between the three experimental variants studied.
- With regard at total chlorophyll content expressed in units SPAD there are significant differences between the three experimental variants. Thus at the stage 1.3 - 1.5 can be seen that if at untreated variant was recorded the lowest total chlorophyll content, a higher content was recorded for V<sub>2</sub>.
- Related to percentage of dry matter at this show no significant differences between the

three versions 1.3-1.5 at the stage, the highest value recorded in V1. However, in the last stage, there are significant differences, the highest percentage being V2.

- The highest photosynthesis intensity was observed in variant 2 treated with Lithovit foliar fertilizer based on CO<sub>2</sub>. Inside the leaf Lithovit particles decompose and release among other substances, especially CO<sub>2</sub>.
- Highest production per plant was observed at variant 2 compared with control variant. It was also found that a production of variant 1 was close enough to variant 2.

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