THE ACTION OF GROWTH REGULATORS ON THE PROCESS OF PHOTOSYNTHESIS IN TOMATO PLANTS

Mihaela COVAȘĂ[1], Cristina SLABU[1], Alina Elena MARTA[1], Carmen Doina JITĂREANU[1]

e-mail: miha_bologa@yahoo.com

Abstract

This research was conducted to determine the effects of two biostimulants on photosynthesis processes of two tomato cultivars, in greenhouse conditions. This study was carried in 2021 at the ICAM Iasi under greenhouse condition. The biological material was represented by two tomato cultivars (*Drops and Chiquita*). The bifactorial experience was conducted in a pots experiment in randomized blocks with three repetitions. The application of biostimulants (*Bactamil and Agromax-Cap*) was done every seven days by foliar spraying throughout the vegetation period. Research was focused on the influence of biostimulants on the photosynthesis process. It has been shown that the chlorophyll content of the leaves is closely related to the mineral nutrition of the plant. The value of chlorophyll content increases with the amount of nitrogen in the leaves, which is why the high values indicated by SPAD show a healthy growth from a nutritional point of view. Plants treated with biostimulants had higher values of the total chlorophyll content compared to the control group, which demonstrates an intensification of the photosynthesis process. The yield of the *Agomax – Cap* stimulator gives better results in terms of the increase in chlorophyll content in the varieties studied and as a result, will also increase the production efficiency.,

Key words: tomato, growth regulators, photosynthesis, SPAD

Biostimulants can help make soils more fertile by restoring a level of organic matter needed for healthy plant growth, also reduce abiotic stress caused by drought or high soil salinity.

Biostimulants are products obtained from diferent organic or anorganic substances or microorganisms, that are able to improve plant productivity growth, and decrease the negative efects of abiotic stresses (Bulgari R. *et al*, 2012; Du Jardin, 2015). The mechanisms activated by biostimulants are often difcult to identify and are still under investigation (Paul K. *et al*, 2019).

Tomatoes culture is number one in greenhouses and solariums that is why it is increasingly desired to increase the productive potential, especially in winter. This goal can be achieved with the help of biostimulants. Biostimulants increase the colour of leaves, this is an important quality parameter in vegetable crops, by stimulating chlorophyll biosynthesis or reducing its degradation (Khan W**.** *et al*, 2009; Abbas S.M., Akladious S.A., 2013).

One of the most important physiological processes involved in increasing the productive potential is photosynthesis. Photosynthesis is the basis of plant growth.

Plant biostimulants significantly increased tomato leaf photosynthetic rate (Chenxing Dong e*t al*, 2020).

MATERIAL AND METHOD

This study was carried in 2021 at the ICAM *(Research Institute for Agriculture and Environment)* Iasi under greenhouse condition, and the laboratory analyzes were performed in the plant physiology laboratory within IULS Iasi Romania.

The biological material was represented by two tomato cultivars (*Drops* and *Chiquita*). The bifactorial experience was conducted in a pots experiment in randomized blocks with three repetitions.

The application of biostimulants (*Bactamil* and *Agromax-Cap*) was done every seven days by foliar spraying throughout the vegetation period (3 treatments T1, T2, T3). Research was focused on the influence of biostimulants on the photosynthesis process. This physiological process was monitored by the total chlorophyll content of the leaves measured with the SPAD device, we also determined the content of chlorophyll pigments and leaf flavonoids by the spectrophotometric method and also during the vegetation period we monitored the fluorescence of the chlorophyll using the fluorimeter.

[1] "Ion Ionescu de la Brad" University of Life Sciences, Iaşi, Romania

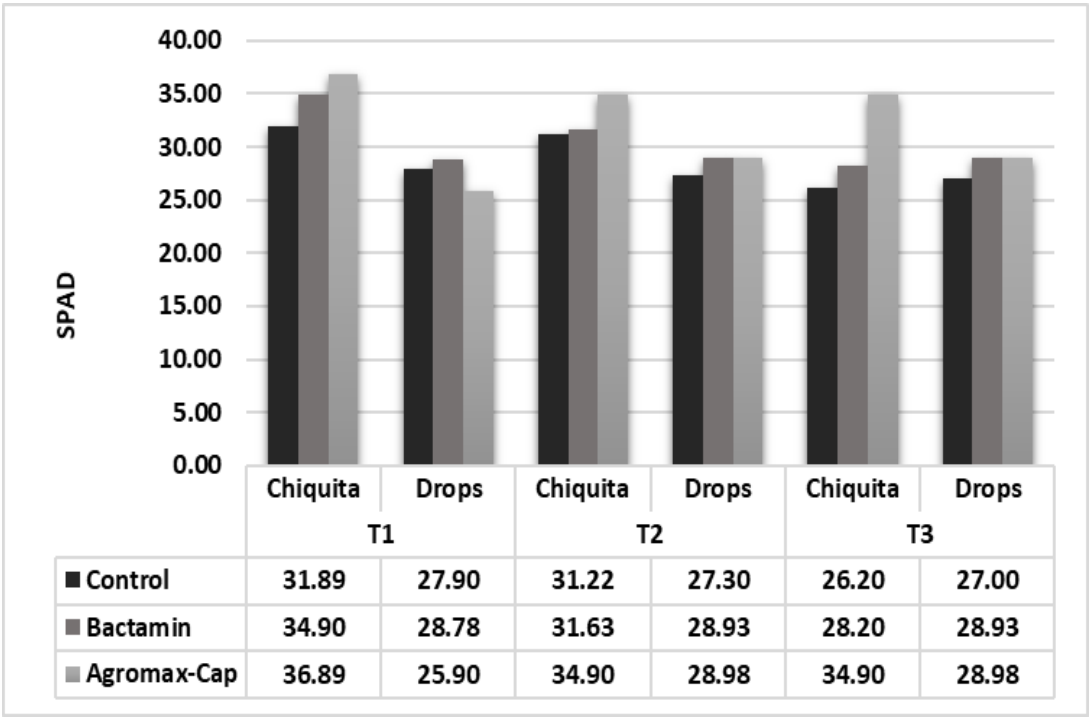
RESULTS AND DISCUSSIONS

Based on the data provided by the SPAD device, the effect of certain environmental factors or treatments applied to plants on the total chlorophyll content of the leaves can be assessed. Because the chlorophyll content present in the leaves is closely related to the mineral nutrition of the plants, it has been shown that the value of chlorophyll content increases in proportion to the amount of nitrogen in the leaves, high values indicated by SPAD highlighting a nutritionally healthy plant.

The average chlorophyll content was analyzed at intervals of seven days after the application of biostimulants.

After the first treatment, the results show a higher total chlorophyll content in the two varieties studied in the plants treated with biostimulants, especially in the plants from the *Agromax-Cap* group (*figure 1*).

The *Chiquita* variety presented the highest chlorophyll content at *Agromax* (36.89 SPAD), followed by an average content of 34.90 SPAD units for the *Bactamin* variant and 31.89 SPAD units for the control group. In the *Drops variety*, we also note the highest total chlorophyll content in plants treated with *Agromax-Cap* (29.90 SPAD), followed by the *Bactamin* group (28.78 SPAD), and with the lowest values are the control plants (27.90 SPAD).



	Chiquita	Drops	Chiquita	Drops	Chiquita	Drops
	T1		T2		T3	
Control	31.89	27.90	31.22	27.30	26.20	27.00
Bactamin	34.90	28.78	31.63	28.93	28.20	28.93
Agromax-Cap	36.89	25.90	34.90	28.98	34.90	28.98

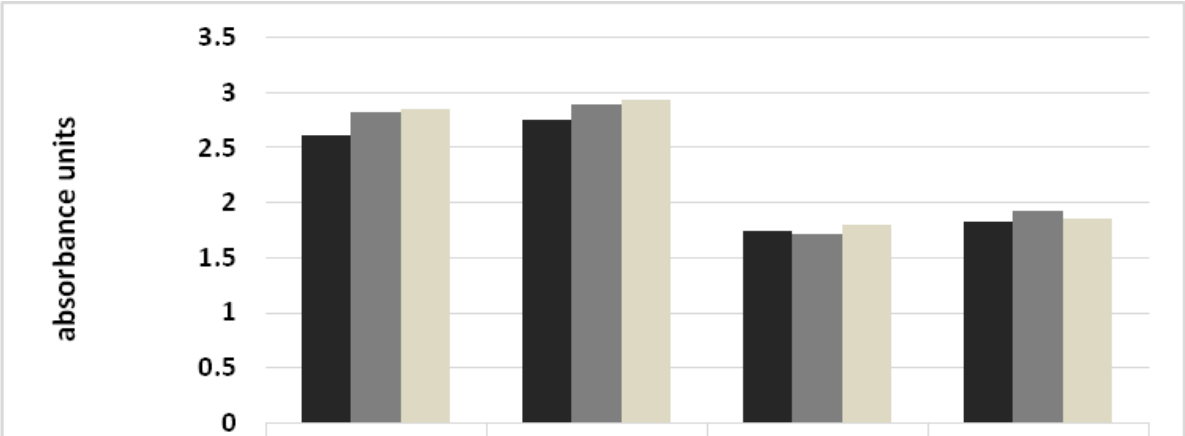
Figure 1 **The influence of biostimulants on the total chlorophyll content expressed in SPAD units**

From the results we can conclude that, in the long run, the application of biostimulants leads to intensification of the photosynthesis process, and in return the *Agomax-Cap* stimulator offers better results in terms of increasing the chlorophyll content of the studied varieties and therefore will increase the potential productive.

In the process of photosynthesis, the absorption of light energy and its transformation into chemical energy is achieved using photosynthetic systems. The photosynthetic system consists of a complex photosynthetic pigments, with an absorption center and a reaction center, making up the photosynthetic unit.

Chlorophyll a 431-433 nm and chlorophyll b 453-454 are components of the absorption center, and chlorophyll a 662-663 nm and chlorophyll b 616-617 nm are components of the reaction center (Jităreanu C.D., 2007). The spectrophotometric analysis of the pigment content of the tomato leaves was performed after the application of the three treatments, a period that coincided with the formation of the inflorescences.

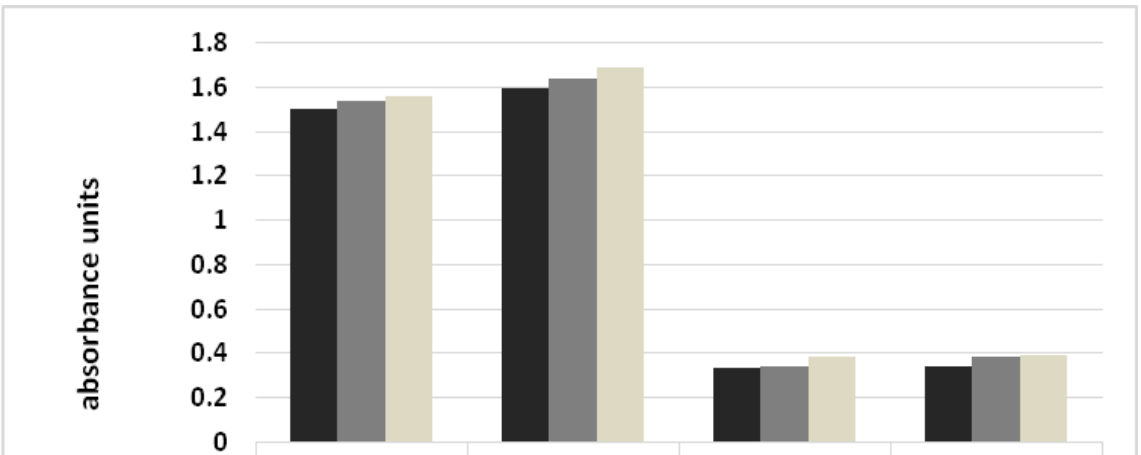
According to the data obtained, the highest values of chlorophyll content of 432 nm, component of the absorption center, were recorded for both varieties, in the case of variants treated with *Agromax* (2.85 and 2.94 u.a.). The lowest content is noticeable in the control variant of both varieties studied (*figure 2*).



	Chiquita	Drops	Chiquita	Drops
	chl. a 431 nm		chl. b 662 nm	
Control	2.62	2.75	1.74	1.83
Bactamin	2.83	2.89	1.72	1.92
Agromax-Cap	2.85	2.94	1.8	1.86

Figure 2 **The influence of biostimulants on the chlorophyll a 431 nm and chlorophyl b 662 nm**

The same behavior as chlorophyll of 433 nm can be observed in chlorophyll of 663 nm, the main component of the absorption center in photosynthetic systems, with a role in capturing light energy and transferring it to the reaction center. In this case, too, both varieties with higher values in the *Agromax-Cap* group (1.56 and 1.69 u.a.) (*figure 3*) are noted, and the lowest chlorophyll content of 663 nm was also recorded in the control group.



	Chiquita	Drops	Chiquita	Drops
	chl. a 662 nm		chl. b 616 nm	
Control	1.5	1.6	0.33	0.34
Bactamin	1.54	1.64	0.34	0.38
Agromax-Cap	1.56	1.69	0.38	0.39

Figure 3 The influence of biostimulants on the chlorophyll a 453 nm and chlorophyl b 616 nm

Flavonoids are plant pigments that predominate in higher plants, found in flowers, fruits, leaves, stems, roots, bark, etc. They were discovered and cataloged by specialists in 1983 and are found in plants in the form of about 6,000 different substances.

Flavonoids are the pigments responsible for plant color and are included in the generic category of vitamin P (citrine)(Moţa C. *et al*., 2016).

Flavonoid pigments, responsible for plant resistance to stressors, were also analyzed in the same period - the formation of inflorescences.

The highest values of flavonoid pigment content were recorded in variants treated with biostimulants.

The *Chiquita* variety showed the highest value in the *Agromax* group (0.91 u.a), followed by 0.78 u.a in the *Bactamin* variant and only 0.54 u.a in the control group (*figure 4*). A slight change is observed in the *Drops* variety, the highest content was registered in the *Bactamine* group (0.96 u.a) followed by *Agromax* (0.85 u.a) and the control group (0.76 u.a).

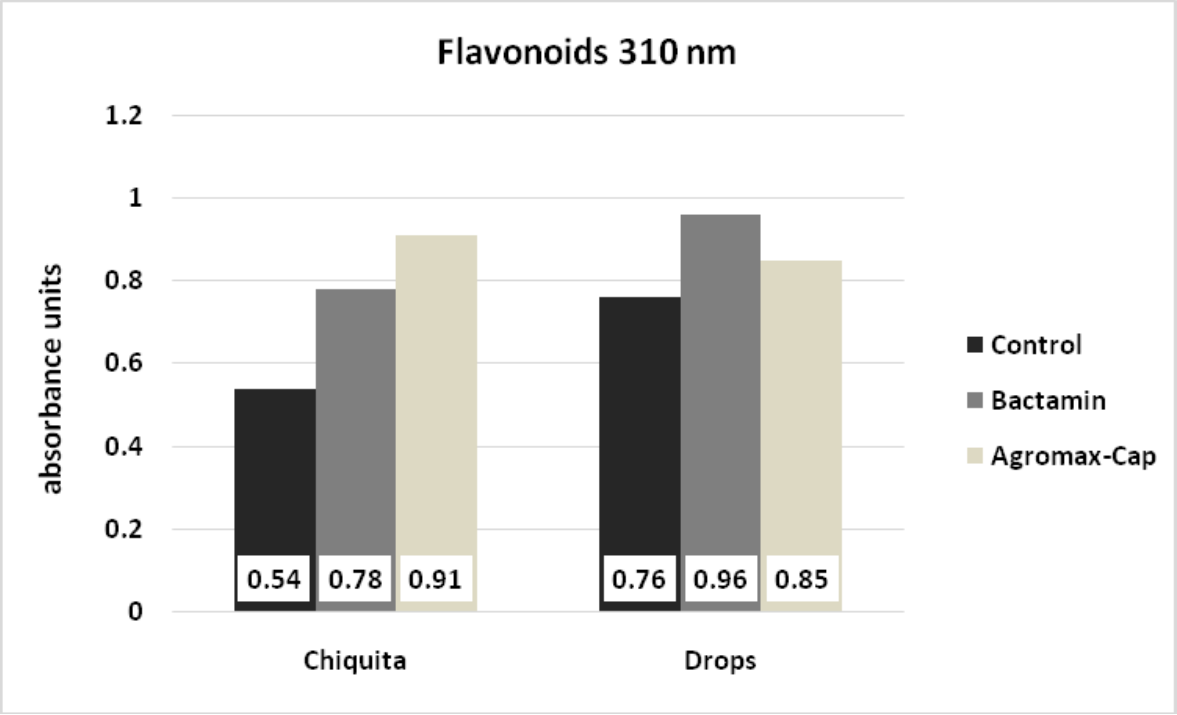
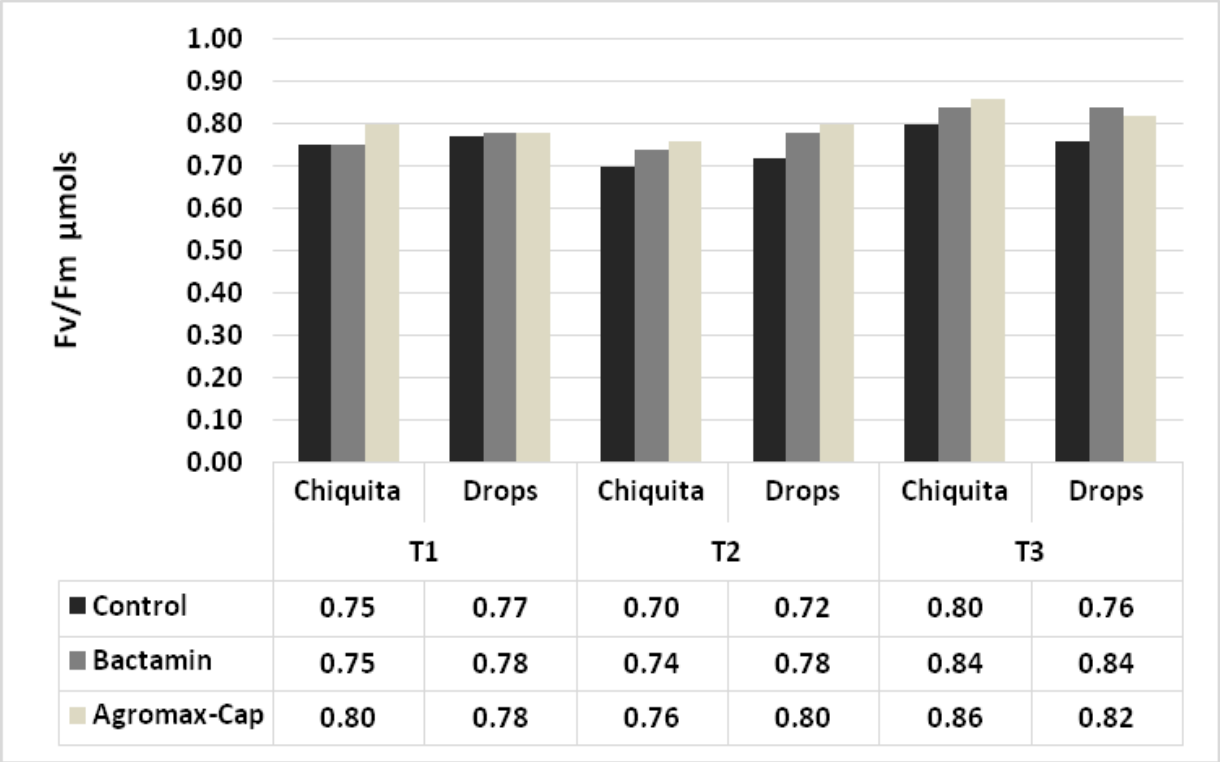


Figure 4 **The influence of biostimulants on the flavonoid pigment**

According to data from the literature, so far it has been shown that chlorophyll fluorescence is influenced by the water supply of plants (Petcu E. *et al*., 2014), mineral nutrition and light intensity. The change of chlorophyll fluorescence properties, respectively the functioning of photosystem II (FS II) is therefore influenced by a series of abiotic factors.

The measurements aimed at determining the values of the Fv / Fm ratio in which they represent the maximum quantum efficiency, indicative of the maximum efficiency of the excitation energy transfer and are calculated using the formula: Fv / Fm = (Fm - F0) / Fm, where: F0 – minimum or initial fluorescence, which occurs when the collector antennas are open to receive light; Fm – maximum fluorescence, recorded after exposure to the excitation source (light spot of the device). Under these conditions, all the sites of the collector antennas are closed, saturated with light quanta.

After the first treatment, the values of the Fv / Fm ratio obtained are the same for the *Chiquita* variety, the control variant and the *Bactamin* variant (0.75 µmol) and higher within the *Agromax Cap* group, totaling an average of 0.85 µmol (*figure 5*).



	Chiquita	Drops	Chiquita	Drops	Chiquita	Drops
	T1		T2		T3	
Control	0.75	0.77	0.70	0.72	0.80	0.76
Bactamin	0.75	0.78	0.74	0.78	0.84	0.84
Agromax-Cap	0.80	0.78	0.76	0.80	0.86	0.82

Figure 5 **The influence of biostimulants on the chlorophyll fluorescence**

In the *Drops* variety, the highest values were recorded in plants treated with biostimulants (0.78 µmoles).

Measurements performed on chlorophyll fluorescence after the application of the second treatment show clear differences between the treated variants and the control group. In the case of both varieties, the plants sprayed with Bactamin and Agromax showed much higher values than the control group, they ranged between 0.70 and 0.80 µmoles.

The exposure of tomato plants to biostimulant treatments positively influenced their ability to capture light, the values of chlorophyll fluorescence being higher in the treated variants compared to control plants. These results correlate with the high values of the total chlorophyll content but also with the content of chlorophyll pigments and flavonoids in the leaves, which indicates a more intense photosynthetic yield than untreated plants but also a higher resistance to certain stressors, ensuring high productive potential.

CONCLUSIONS

Following the analysis of the photosynthesis process, the best variance treated with *Agromax-Cap* biotimulants for both tomato varieties was noted with the best results.

This shows an intensification of the photosynthesis process with a positive impact on the productive potential of fruits / plants.

REFERENCES

Abbas S.M., Akladious S.A, **2013** - *Application of carrot root extract induced salinity tolerance in cowpea (Vigna sinensis L.) seedlings*. Pak. J. Bot., 45: 795–806.

Bulgari R., Franzoni G., Ferrante A, **2019** - *Biostimulants application in horticultural crops under abiotic stress conditions*. Journal Agronomy, 9 (6):306-336.

Chenxing Dong, Ge Wang, Minghui Du, Chenxu Niu, Peng Zhang, Xinyi Zhang, Di Ma, Fangfang Ma, Zhilong Bao, 2020 - *Biostimulants promote plant vigor of tomato and strawberry after transplanting.* Scientia Horticulturae, 267.

Du Jardin, 2015 - *Plant biostimulants: Definition, concept, main categories and regulation*. Sci. Hortic. (Amst.), 196: 3–14.

Jităreanu Carmen Doina, **2007.** *Fiziologia plantelor*. Editura „Ion Ionescu de la Brad", Iași.

Khan W., Rayirath U.P., Subramanian S., Jithesh M.N., Rayorath P., Hodges D.M., Critchley A.T., Craigie J.S., Norrie J., Prithiviraj B, **2009** - *Seaweed Extracts as Biostimulants of Plant Growth and Development*. J. Plant Growth Regul, 28: 386–399.

Moța C., Roșu A., Câmpeanu Gh., 2016. *Compuși bioactivi de origine vegetală. Abordări biotehnologice*. Ed. Universității București.

Paul K., Sorrentino M., Lucini L., Rouphael Y., Cardarelli, M.; Bonini, P.; Reynaud H, Canaguier R., Trtilek M., Panzarová K. **2019** - *Understanding the Biostimulant Action of Vegetal-Derived Protein, Hydrolysates by High-Throughput Plant Phenotyping and Metabolomics: A Case Study on Tomato*. Front. Plant Sci., 10:47.

Petcu E., Schitea M., Drăgan L., 2014 – *The effect of water stress on stomatal resistance an chlorophyll fluorescence and their association with alfalfa yield.* Romanian Agricultural Reserch, 31:113-119.