Biometric Indicators and Yield of Tomato under Conventional and Unconventional Biostimulators

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Abstract

The research consisted of an experiment applying unconventional stimulators to tomato crop, as a measure against chemical stimulators, known as having negative effects on human health. In our research there have been used four unconventional stimulators (Ecostim, $AuCl_4$-50µg, $AuCl_4$-30µg and Chitosan) and a conventional stimulator BNOA, all compared with the untreated control.

Application of stimulators in unconventional farming determined lower productions compared to conventional farming, but is an alternative because determined healthy products. In three of the four unconventional variants, the content of macro- and microelements in plants was higher.

Keywords: *Lycopersicon esculentum,* macro- and microelements, production, stimulator

Introduction

Sustainable farming is an alternative to intensive agriculture, based on efficient methods and means of production (Stoleru *et al*., 2014). In conventional agriculture, during the green revolution, many stimulating chemicals such as BNOA, SDMA 2.4-D, Tomato-stim, Atonik have been used to stimulate flower setting, but these products have a negative effect on the human health (Watanabe *et al*., 2015; Munteanu *et al*., 2010). The notion of organic farming emerged at the beginning of the 20th century, being a very important area for ensuring sustainable development (Stoleru, 2013). From literature, it is well known that tomato pollen at temperatures above 30 °C, does not germinate and drips very quickly without self-fertilization.

BNOA 2-Naphthoxyacetic acid is a growth regulator that prevents fruit from early dropping and promotes proliferation of roots (Apahidean *et al*., 2012). BNOA is well known tomato stimulator in the conventional system, but with carcinogenic effects.

Chitosan is a polysaccharide made from chitin, resulted from shrimp shells and other crustaceans with sodium hydroxide. Chitosan has a wide range of uses, both in agriculture, medicine, winemaking and in limiting fat absorption. The product is used to treat seeds, but also as a bio-pesticide, helping plants to fight fungal infections (Malerba *et al*., 2016; Anitha *et al*., 2014).

Gold tetrachloride is an anorganic compound used as a precursor in the synthesis of gold nanoparticles, which has various applications in different fields ranging from agricultural and food industry to medicine. It has the potential to stimulate the production of various plants (Siddiqi and Husen, 2016).

Ecostim is a glycoside of furostanol and a natural substance belonging to the saponin class. This product has been obtained by alcoholic extraction from tomato seeds, it is a bioactive

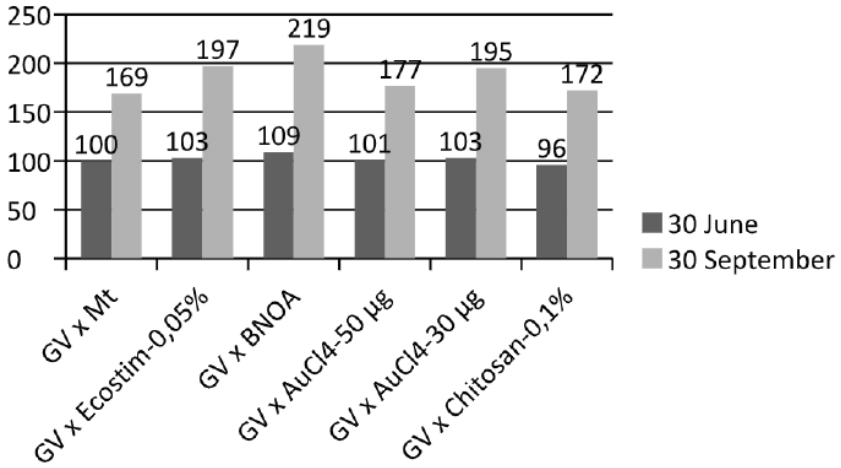

Figure 1. Results of tomato plant height (cm)

Table 1. Influence of stimulators on morphological indices of tomato

Treatment	Inflorescences per plant	No. of leaves	No. of flowers per plant	No. of fruits per plant	Fruit weight (g)
Control	3.02	16.06	15.7	13.5	181
Ecostim	3.24	16.72	18.1	16.9	218
BNOA	4.35	18.82	29.6	27.2	207
$AuCl_4$-50 µg	3.27	17.2	18.6	16.4	190
$AuCl_4$-30 µg	3.46	16.54	20.2	18.4	201
Chitosan	3.20	16.48	17.7	15.4	220

substance of plant origin and has antiviral and antifungal properties (Munteanu *et al*., 2011).

The research aimed to assess the possibilities of using unconventional stimulators for tomato crop, for the preservation of the ecological balance, as compared to chemical stimulation.

Materials and methods

The research was carried out in a horticultural farm "V. Adamachi "Iasi, with 47° 10' 37.257" N 27° 30' 6.20" E GPS coordinates using Gravitet F1 tomato. The experiment consisted of 5 treatments: Ecostim-0.05%, $AuCl_4$-50µg–0.05%, $AuCl_4$-30µg-0.05%, BNOA-0.1% and Chitosan-0.1% compared with the untreated variant, sprayed in water suspension. Each experimental plot comprised 5 plants, in 3 replications, in total 90 harvested tomato, analysed on the 30th of June (803 BBCH) and the 30th of September (808 BBCH). During the vegetative period determinations were made on the following production indicators: number of flowers and fruits, fruit weight and total yield. Macro- and microelements were analysed by EDXS method.

Statistical analysis was carried out using ANOVA, for degrees of confidence of 95%, 99% and 99.9%, by SPSS version 20.

Results and discussions

Obtaining a sustainable harvest in tomatoes is conditioned by the growth and development of plants. Results on the effect of stimulators on plant growth are presented in Figure 1.

In the first determination (30th of June), the average height varied from 96 cm for Chitosan treatment to 109 cm for BNOA treatment. In the second determination (30th of September) the height varied between 169 cm for tomatoes treated with distilled water and 219 cm for tomatoes treated with BNOA, demonstrating that treatment with conventional bio-stimulators has greatly influenced the plant growth. In the case of gold tetrachloride, the best growth results were achieved by plants treated with 30µg $AuCl_4$, the height reaching 195 cm.

All treatments had a positive influence on the vegetative growth of the tomato plants.

Table 2. Effect of stimulators on tomato yield

Treatment	Total yield (kg/ha)	Relative production %	Difference from control kg/ha	Significance of difference
Control	59,890	100	0	ns
Ecostim	90,124	150	30,234	***
BNOA	138,014	230	78,124	***
AuCl4-50 µg	76,353	127	16,463	**
AuCl4-30 µg	90,706	151	30,816	***
Chitosan	83,132	139	23,242	***

LSD 5%=8,987 kg/ha; LSD 1%=12,775 kg/ha; LSD 0.1%=18,135 kg/ha
ns- not significant; ** - differences distinct positive; ***- very positive differences

Table 3. Content of macro- and micro-elements in tomato

Chemical element %	Treatment					
	Control	Ecostim	BNOA	$AuCl_4$-50µg	$AuCl_4$-30µg	Chitosan
Ca	0.4	0.3	1.8	2.0	4.8	1.8
Cl	0.3	0.2	1.2	1.7	0.6	1.1
Mg	0.8	0.7	0.4	0.9	1.2	0.7
K	0.4	0.4	1.2	1.8	1.2	1.1
S	0.1	0.1	0.1	0.2	0.3	0.2
Na	0.0	0.0	0.0	0.2	0.1	0.0

Following the analysis of tomato plant growth processes, it can be noticed that the height of the plants, the number of leaves and inflorescences are variable, these processes being influenced by the biostimulator used. Among all experimental treatments the most significant increase of tomatoes treated with BNOA can be observed, regarding stem height, number of leaves and inflorescences (Tab. 1).

The number of inflorescences per plant varied according to the treatment, ranging from 3.02 in control to 4.35 in BNOA trated variant. The fruit number varied from 13.5 for control to 27.2 under the same chemical stimulator. Fruit weight ranged from 181 g in control to 220 g for Chitosan treatment.

The application of chemical biostimulators revealed the highest yield among all experimental variants with BNOA (138.014 kg ha^{-1}), while treatment with Ecostim biological stimulator led to a lower yield (90.124 kg ha^{-1}) (Tab. 2).

Except for AuCl4-50µg treatment with which resulted a distinct significant increase of yield for all the other treatments very significant increases of yield were revealed, as compared with control.

Data presented in Table 3 show that macro- and micronutrients content in tomato is higher in variants treated with $AuCl_4$-50µg, $AuCl_4$-30µg, Chitosan compared to BNOA. In the variants treated with Ecostim and Control, the mineral content was 2-3 times lower than in the BNOA treated variant.

Conclusion

Following the analysis of tomato plant growth processes, it can be seen that the height of plants, number of leaves and inflorescences are variable, these characters being influenced by the biostimulator used. From all the analysed variants, a significant increase of stem height, number of leaves and set flowers of tomatoes treated with BNOA can be observed. The other variations in leaf and inflorescences have evolved numerically in parallel with the height.

The results obtained by using Ecostim as non-conventional bio-stimulators increased yield with approximately 50% than control.

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