

FERTILIZATION SYSTEMS EFFECT ON THE GROWTH AND PRODUCTIVE MANIFESTATIONS OF GREENHOUSE TOMATOES, CULTIVATED AS A SOIL CROP

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Abstract

The purpose of the study is optimization of fertilization with the greenhouse tomatoes. The experimental work has been brought out during the period 2018-2019, in the test field of department "Plant Production" in a polyethylene greenhouse, without heating, with two varieties tomatoes - Grando F₁ and Pink Rok F₁, grown as a soil crop. Three schemes of fertilization have been tested with five formulations fertilizers for fertigation: brought in as main fertilization /control/ and a combined scheme: fertilization in seven and three days during the vegetation on the increase rate of the vegetative mass and productivity of the plants.

The results from the tested fertilization schemes show a positive effect on the growth and productive manifestations with both tomato varieties in comparison with the control. It is statistically proven that the impact is bigger with the combined fertilization by YaraTera Kristalon Special (18-18-18); YaraTera Kristalon Lazur (20-05-10); YaraTera Kristalon Orange (6-12-36); YaraTera Kristaflex Yellow 12-32-11 and YaraLiva Calcinit, brought in in 3 days, in comparison with the fertilization in 7 days, which is expressed stronger for variety Grando F₁. The results about the number and mass of the fruit per plant are analogous. By the analysis carried out on the averaged data is established that variety Grando F₁ exceeds as per productivity variety Pink rok F₁ by 11.1% (fertilization in 3 days) and 4.8% (fertilization in 7 days), as the differences are mathematically proven.

Key words: *Solanum lycopersicum L, polyethylene greenhouse, fertilization, growth manifestations, productivity.*

INTRODUCTION

The greenhouse vegetable farming is one of the branches of the agriculture in our country, which has potential to generate significant revenues from a unit of area. The technologies in this production are developing very intensively. The efficiency of the vegetable farming is in direct connection with the scientific researches in the field of fertilization. Different models for maintaining and perfection of the nutritional regime are continuously studied and created, alternative, ecologically sound solutions are introduced, which comply with the requirements of the contemporary agriculture (Sengalevich et al., 2007; Tringovska & Kanazirska, 2007; Arnaudov et al., 2007; Boteva et al., 2013; Kostadinov et al., 2013; Tringovska et al., 2014; Naskova, 2017).

Over the last years in the countries with developed agriculture is carried out research work for optimization of the nutritional regime

of the greenhouse crops (Nakano & Akimasa, 2003; Pascale et al., 2004). The emphasis is put on perfection of the fertilization models, based on more effective usage of the nutrient substances and allowing decrease of the brought in quantities in the soil (Kolota & Osinska, 2000; Naskova, 2017). This is necessary and in relation with the super intensive character of the greenhouse production, in which are introduced and are grown contemporary hybrids with valuable economic qualities and very high biological potential.

Different formulations fertilizers are offered at the Bulgarian market. The right fertilization, conformed with the permanently changing varietal composition, imposes to be brought out the researches for their usage with the vegetable crops in greenhouses, including with tomatoes (Martins, 2010; Tringovska, 2012; Márquez-Hernández, 2013). The broadening of the researches in our country is necessary in

order to be optimized the nutritional regime by offering appropriate schemes for fertilization, guaranteeing the obtaining of stable yield of high quality, which can guarantee the competitiveness at the Bulgarian market.

The purpose of the study is to be determined the impact of fertilization systems on the growth and the productive qualities of the greenhouse tomatoes, grown as a soil crop with purpose optimization of the nutrition.

MATERIALS AND METHODS

The experimental work has been brought out during the period 2018-2019 in a non-heated polyethylene greenhouse of department Plant Production - Technical University Varna with two varieties greenhouse tomatoes - Pink Rok F₁ and Grando F₁. Three fertilization schemes have been tested with five formulations fertilizers for fertigation. The plants are grown as a soil crop.

Conditions of the experiment

Variety: Variety Pink Rok F₁ and Variety Grando F₁;

Sowing: 02-03.03. - peat-perlitic substrate (1vol.:10 vol.), in terrines with 160 clusters;

Pricking out: 01-03.04. - peat-perlitic substrate (1 vol.:10 vol.), terrines with 28 clusters

Planting: 18-20.04.

Harvesting: until 08-10.08.

Density of the crops: 3 plants/m²

Combing (pruning): Phase 4-5th flowerhead

Harvesting until: 30.09.

Fertilization schemes:

1. Control - only main fertilization by mineral fertilizer YaraMila Cropcare (8-11-23), 60 kg/da.

2. Fertilization for the whole vegetation by mineral fertilizers - nitrogen 18 g per plant; phosphorus 12 g per plant; potassium 28 g per plant, as the fertilization is carried out in 3 days.

3. Fertilization of the whole vegetation by mineral fertilizers - nitrogen 18 g per plant; phosphorus 12 g per plant; potassium 28 g per plant, as the fertilization is carried out in 7 days.

Characteristics of the fertilizers:

YaraTera KRISTALON Special (18-18-18) -

It is appropriate for crops and phases of their development, when it is necessary the proportion between the main nutrient elements nitrogen:phosphorus:potassium to be - 1:1:1;

YaraTera KRISTALON Lazur (20-05-10) -

A specific proportion between the nitrogen, phosphorus and potassium for crops and phases of their development, which require high nitric nutrition;

YaraTera KRISTALON Orange (6-12-36) -

A formula with low content of nitrogen and high content of potassium, it stimulates the ripening of the fruit;

YaraTera KRISTAFLEX Yellow 12-32-11 -

With high content of phosphorus. It stimulates the faster and better root-taking of the agricultural crops after pricking out;

YaraLiva CALCINIT - it is applied in the initial stages of the crop development and during formation and growing of the fruit, it is against calcium deficiency.

The plants are cultivated in soil and in peat substrate (Klasman TS 3). The experiment is set out as per the method of the long plots in 4 repetitions, with six plants in a repetition, with size of the harvesting area 6 m².

The quantity of the mineral fertilizers is determined on the grounds of an agro-chemical analysis of the soil. The application of the fertilizers has been carried out at background main fertilization by YaraMila Cropcare. The main fertilization is one and the same for all variants.

The cares for the plants growing are as per technology for early spring greenhouse production, without heating. Earth bee *Bombus terrestris* has been used for pollination.

The soil from the experimental plot is leached chernozem with a dark humus horizon (FAO, 2000), medium reserved with mobile phosphorus and nitrogen and well reserved with potassium (Table 1). The reaction of the soil solution is neutral pH = 7.05; the content of humus is 3-4%, as it decreases in depth; total salt concentration 0.34 mS/cm.

Table 1. Agrochemical analysis of the soil before the main fertilization

pH	Hummus	EC mS/cm	Nutrients - ppm				
			N	P	K	Ca	Mg
7.05	3-4%	0.34	133.3	8.6	117.1	121.1	80.5

The main fertilization is one and the same for all variants, as for the purpose 60 kg/da mineral fertilizer YaraMila Cropcare (8-11-23) has been brought in.

Indexes of the study

Microclimatic conditions

Everyday at 8.00 AM and at 2.00 PM are registered:

- temperature of the air (°C) – there has been reported minimum-maximum thermometer at height 5-6 leaf from the top of the plants.
- relative air humidity (%). Measured by a digital hygrometer HD8501H.
- temperature of the substrate (°C). It is measured at depth 8 cm by a digital soil thermometer.

Agrochemical analysis of the soil. The content of the assimilable nutritional elements has been determined by soil analysis (before setting of the experiment) in a water extract 1:2 vol./vol. There have been determined pH – potentiometrically; total concentration of the soluble salts - as per electrical conductivity, nitrogen - by an ion selective analyzer; phosphorus - spectrophotometrically; calcium and magnesium - complexometrically.

Biometric analyses: Rate of the stem growing and leaves formation - in 15 days until the end of the vegetation of 6 marked plants from repetitions are measured – the height of the stem (cm) and number of the leaves per plant.

Productivity: At mass fruit-bearing are analyzed as per 6 plants of repetition for determination of: number of fruit - number/plant; mass of the fruit - g/plant;

Mathematical processing of the data: The results are processed by a multidirectional comparative analysis as per the method of Duncan, multiple range test and T-test (SPSS software).

RESULTS AND DISCUSSIONS

Microclimatic conditions

The registered data about the microclimatic factors show that during the period of bringing

out of the experiments, the temperature conditions are close to the requirements of the tomato plants, while the relative air humidity in the afternoon hours in separate days is under the optimum for this crop.

Growth manifestations

The formation and the functional condition of the vegetative parts of the plants depend on many factors, including and nutrition. The balanced feeding of the plants is one of the main factors for impact on the growth manifestations and the productivity.

A summary index about the growth manifestations is the size of the formed fresh vegetative over-ground mass. It is proven about the reported period on the average that with variety Grando F₁ the plants have registered higher values of the growth rate of the stem with Variant 1 (fertilization in 3 days) (41.3 cm/30 days), the effect is weaker with Variant 2 (fertilization in 7 days) (39.1 cm/30 days), as the increase is respectively by 21.5% and 15.0% in comparison with the control (Figure 1).

The results are analogous and about variety Pink Rok F₁. The plants of Variant 1 have faster growth rate of the stem (37.2 cm/30 days), which is proven to differ from Variant 2 (35.0 cm/30 days), as the increase in comparison with the control is by 17.7% and 10.8%. The impact on the growth rate of the stems is proven to be weaker with the control variant.

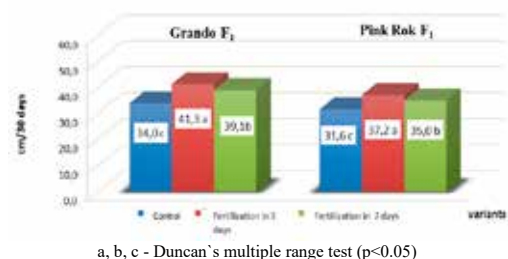


Figure 1. Stem growth rate (cm/30 days) - average for the period

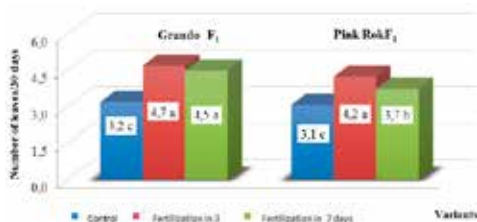
In order to be clarified the meaning of the factor “Variety” on the growth rate of the stems is analyzed the impact of fertilization in comparison with the tested varieties. Statistically significant differences have not been established between the two varieties on the average for the period of study, the increase

in comparison with the control is respectively by 11.0% and 11.7% (Table 2).

Table 2. Influence of fertilization on the growth rate of the stem, depending on the variety - average for the period (cm/30 days)

№	Variants	Variety Grando F ₁	Variety Pink Rok F ₁	Difference	Proof	%
1	Control	34.0	31.6	2.4	ns	107.6
2	Fertilization in 3 days	41.3	37.2	4.2	++	111.0
3	Fertilization in 7 days	39.1	35.0	4.1	++	111.7

The impact of the fertilization on the rate of leaves formation is established on the average for the period of study (Figure 2). The highest values of this index are established with variety Grando F₁ with fertilization in 3 days (4.7 pieces leaves/30 days), with close and unproved differences are the plants, the fertilized in 7 days (4.5 pieces leaves/30 days), the increase in comparison with the control is respectively by 46.9 and 40.6%. Statistically proven are the differences between the variants of fertilization with variety Pink rok F₁, as the increase is by 35.5% (fertilization in 3 days) and 19.4% (fertilization in 7 days).



a, b, c - Duncan's multiple range test (p<0.05)

Figure 2. Rate of leaf formation - average for the period

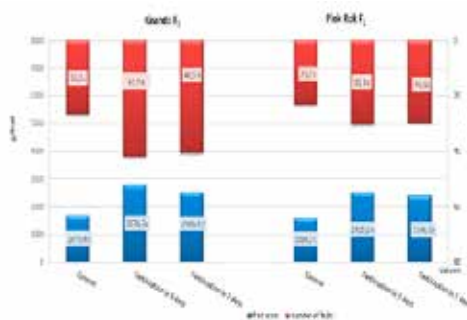
On the average for the period of study the differences in the rate of leaf formation between the two varieties are proven with both variants of fertilization, stronger expressed with variety Grando F₁ (Table 3), as the increase is by 21.6% (fertilization in 7 days) and 11.9 % (fertilization in 3 days) in comparison with variety Pink rok F₁.

Proven differences between the two fertilization schemes have been established in comparison with the number and mass of the fruit on the average for the period.

Table 3. Influence of fertilization on the rate of leaf formation depending on the variety (number of leaves/ 30 days)

№	Variants	Variety Grando F ₁	Variety Pink Rok F ₁	Difference	Proof	%
1	Control	3.2	3.1	0.1	ns	103.2
2	Fertilization in 3 days	4.7	4.2	0.5	+	111.9
3	Fertilization in 7 days	4.5	3.7	0.8	++	121.6

With Gradno F₁ variety the number of fruit varies from 26.6 up to 41.9 on the average per plant. Bigger increase is registered with Variant 1 (fertilization in 3 days), followed by Variant 2 (fertilization in 7 days), as the increase of the number of fruit in comparison with the control is respectively by 57.6% and 51.5% (Figure 3). With variety Pink Rok F₁ the number of fruit varies from 23.2 up to 30.3 on the average per plant. As with Variant 1 (fertilization in 3 days) the number of fruit is the biggest, the increase in comparison with the control is by 32.9%, the effect is weaker of the fertilization with Variant 2 (fertilization in 7 days) - 27.2%.



a, b, c - Duncan's multiple range test (p<0.05)

Figure 3. Mass and number of fruits per plant

The average mass of the fruit for variety Grando F₁ varies from 1675.0 g up to 2776.7 g/plant. It is proven that the biggest mass of the fruit is with Variant 1 (fertilization in 3 days), as the increase in comparison with the control is by 65.8%, while the increase of the fruit mass with Variant 2 (fertilization in 7 days), in comparison with the control is by 49.6% (Figure 3). Analogous are the data, which are obtained for variety Pink Rok F₁, as the effect in comparison with the control is expressed weaker (57.5% and 50,7 %).

Statistically significantly stronger is the impact of fertilization on the number and mass of the fruit with variety Grando F₁ (Table 4). Statistically significant differences between the varieties regarding the formed fruit per plant have not been established on the average for the period of the experiment.

Table 4. Influence of fertilization on the number of fruits of plants depending on the variety

№	Variants	Variety Grando F ₁	Variety Pink Rok F ₁	Difference	Proof	%
1	Control	26.6	23.2	3.4	++	114.7
2	Fertilization in 3 days	41.9	30.3	11.3	+++	138.3
3	Fertilization in 7 days	40.5	29.6	10.9	+++	136.8

By the analysis carried out of the averaged data is established that variety Grando F₁ exceeds as per productivity variety Pink rok F₁ by 11.1 % (fertilization in 3 days) and 4.8% (fertilization in 7 days), as the differences are mathematically proven (Table 5).

Table 5. Influence of fertilization on the fruit mass of plants depending on the variety

№	Variants	Variety Grando F ₁	Variety Pink Rok F ₁	Difference	Proof	%
1	Control	1675.0	1586.7	88.3	+	105.6
2	Fertilization in 3 days	2776.7	2499.6	277.1	++	111.1
3	Fertilization in 7 days	2506.4	2391.5	114.9	+	104.8

CONCLUSIONS

The applied fertilization schemes render positive impact on the formed fresh vegetative over-ground mass.

Higher values of the growth rate of the stem are registered with variety Grando F₁ with Variant 1 (fertilization in 3 days), the effect is weaker with Variant 2 (fertilization in 7 days), as the increase is respectively by 21.5% and 15.0% in comparison with the control.

On the average for the period of study the differences in the rate of leaf formation between the two varieties are proven and with both variants of fertilization, as it is expressed stronger with variety Grando F₁, as the increase

is by 21.6% (fertilization in 7 days) and 11.9 % (fertilization in 3 days) in comparison with variety Pink rok F₁.

A positive effect has been established by the testing of the two fertilization schemes on the formation of fruit number per plant in comparison with the control. With both varieties tomatoes Grando F₁ and Pink Rok F₁ this is best expressed with Variant 1 (fertilization in 3 days). The fertilization impact on the number and mass of fruit with variety Grando F₁ is statistically significantly stronger.

It was established by the analysis carried out of the averaged data that variety Grando F₁ exceeds as per productivity variety Pink rok F₁ by 11.1% (fertilization in 3 days) and 4.8% (fertilization in 7 days), as the differences are mathematically proven.

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