Bulgarian Journal of Agricultural Science, 23 (No 5) 2017, 820–825
Agricultural Academy

EFFECT OF FERTILIZATION, GROWING SCHEME AND VARIETY ON ECONOMIC PRODUCTIVITY IN BIOLOGICAL TOMATO PRODUCTION

HRISKA BOTEVA[1]; PLAMENA YANKOVA[2]
[1] *Agricultural Academy, Maritsa Vegetable Crops Research Institute, BG-4003 Plovdiv, Bulgaria*
[2] *Technical University, BG-9000 Varna, Bulgaria*

Abstract

Boteva, H. and P. Yankova, 2017. Effect of fertilization, growing scheme and variety on economic productivity in biological tomato production. *Bulg. J. Agric. Sci.*, 23 (5): 820–825

The experimental work is carried out during the period 2014-2016 in the Technical University of Varna. The following biological products for fertilization are studied: Biosol, Biofa and Emosan. The schemes for growing of determinate tomato variety Kopnezh F_1 and Nikolina F_1 are two – single-row and double-row raised bed. The purpose of the study is to establish the effect of bio-products for fertilization and growing scheme on the economic productivity of tomato, grown in the conditions of biological agriculture.

Bio-products included in the study increase the yields of both varieties. The highest yields, in the single-row scheme, were obtained from the plants grown on the background of Emosan + Biofa. The increase towards the control was with 26.3% (Kopnezh F_1) and with 25.3% (Nikolina F_1). The average effect of the bioproducts used is higher in Kopnezh F_1 variety (21.1%), compared to Nikolina F_1 (19.5%). It is proven greater influence of fertilization on both schemes of growing which is strongly expressed in the single-row scheme, while the effect of the variety is more slightly expressed.

The index of productivity for Kopnezh F_1 variety, averagely for the study period, in both schemes of growing is 3.6, and for the Nikolina F_1 variety – in single-row scheme – 3.8 and 4.0 for the double-row scheme.

Key words: Solanum lycopersicum L.; bioproducts; growing scheme; variety; yield; index productivity

Introduction

The development of organic agriculture is provoked by the increasing interest to ecological products in worldwide significance (Panayotov, 2000). The production of vegetables with high quality and biological value is a subject of increasingly extensive researches in modern horticultural science, which requires the optimization of some technological elements. Alternative, ecological solutions are tried to be found, giving a favorable and efficient nutrition regime that creates the conditions for realizing of the plant productive capacity (Shaheen et al., 2007; Boteva and Cholakov, 2010).

The use of organic fertilizers as an alternative to chemical fertilizers increases vegetative growth, yield and fruit quality in vegetable crops (Poudel et al., 2002; Aly, 2002). According to a study by Boteva and Georgieva (2013) and Boteva (2014), the treatment of pepper and tomato seeds with organic products has a positive effect on the biometric indices of the seedlings.

A positive effect of the application of bio-fertilizers on the growth, development and yield of tomato, cucumber, cabbage, pepper, onion, marrow and potato is established (Dimov et al., 2007; Vlahova and Popov, 2013; Tringovska and Kanazirska, 2007; Rasool et al., 2008; Vlahova and Popov, 2013). The production is characterized with better taste compared to the conventional production (Rembialkowska, 2000; Szafirowska and Babik, 2005). Breeding programs are directed to development of hybrid varieties that are more

**Corresponding author*: hriska_mb@abv.bg

resistant and suitable for biological production (Antonova, 2012; Antonova et al., 2012; Todorova, 2013; Todorova et al., 2013; Nacheva et al., 2013).

Materials and Methods

The experimental work was conducted during the period 2014-2016 on carbonate-chernozem soil of the experimental plot at the Technical University of Varna with determinate tomato varieties Kopnezh F_1 and Nikolina F_1. Two schemes of tomato growing on raised bed were studied – single-row and double-rows.

In order to determine the effect of applied bio-products on tomato yield formation, the following treatments were included in this study:

1. Control – non-fertilized;
2. Biosol – 100 kg/da – single treatment of the soil before planting;
3. Biosol – 100 kg/da + Biofa /0.3-0.5%/– foliar application: phenophases – full blossoming and start of fruit formation;
4. Emosan – 20 L/da, local soil treatment with the irrigation system – twofold: 15 L/da before sowing and 5 L/da in full blossoming phase;
5. Emosan + Biofa /0.3-0.5%/– foliar application: phenophase – full blossoming and start of fruit formation.

Materials and Methods

Variety Kopnezh F_1 – (from the breeding collection of the "Maritsa" Vegetable Crops Research Institute – Plovdiv). A new, high-yielding, determinate hybrid variety suitable for fresh consumption and processing in juices and pulps. Fruits are large, 180-280 g weight, round, thick, crack resistant with very good taste, optimal firmness and storage life.

Variety Nikolina F_1 – (from the breeding collection of the Institute of Genetics – Bulgarian Academy of Sciences BAS). Determinate hybrid variety for fresh consumption and processing. Plants are very vital, with a medium-spilled habitat. The fruits are large, with an average weight of 220-250 g, firm, with good shelf life. Resistant to tobacco mosaic virus, Verticillium wilt, Fusarium wilt and highly tolerant to brown leaf spots.

Characteristic of bioproducts used in this experiment

Biosol (Sandoz GmbH, imported by Gimel) **–** granulated organic fertilizer with long-lasting effect. This bio-product gives balanced nutrition of the plants and it supplies them with necessary macro- and micro-elements during the whole vegetation period. The nitrogen being organically fixed is easy to be absorbed by the plants.

Emosan, HemoZym NK (Arkobaleno, Italy) – organic nitrogen fertilizer with long-lasting effect on the soil and plants.

Biofa (BIOFA Naturprodukte W. Hahn GmbH, imported by Amititsa Ltd) – organic fertilizer based on brown algae extract. It has an effect on fruit quality by phosphorus and potassium easy to be absorbed and in bioactive form.

Indexes and methods of the study

Economic earliness – it is determined by the yield obtained till August the 5-th (according to the methods of the Executive Agency for Variety Testing, Field Inspection & Seed Control – EAVTFISC, Sofia). It was chosen well ripe fruits only.

Yield – kg/da. Containing standard fruits from all harvests up to September the 30-th.

Index of productivity (g) – fresh fruit weight/fresh leaf-stem weight by I. Dimov (1983).

Mathematical processing of the results

Duncan·s Multiple range and multiple F-test and two-way analysis of variance (Duncan, 1955; Lakin, 1990).

Results and Discussion

The results from the two-way analysis of variance in variety Kopnezh F_1 show that averagely for the period of study the factor Bio-product (A) has a stronger effect on the yield formation – 47.7% from the total variation that is statistically significant while the effect of the factor Scheme (B) is weaker – 34.8. The interaction between the two factors (A*B) has also an influence on yield formation – 11.1% (Figure 1).

The same tendency is observed in variety Nikolina F_1.

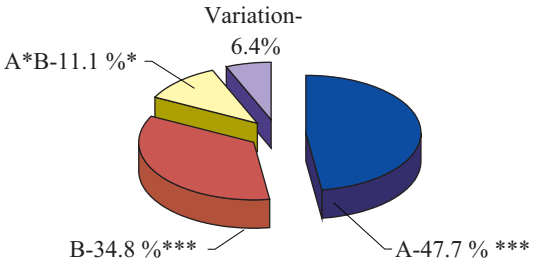

Fig.1. Effect of Bio-product and growing scheme on the yield of variety Kopnezh F_1

The effect of the factor Bio-product (A) on the yield formation is greater – 52.8%, and the effect of factor Scheme (B) is weaker – 25.0%. The differences are statistically significant (Figure 2).

It was established that for the period of the experiment

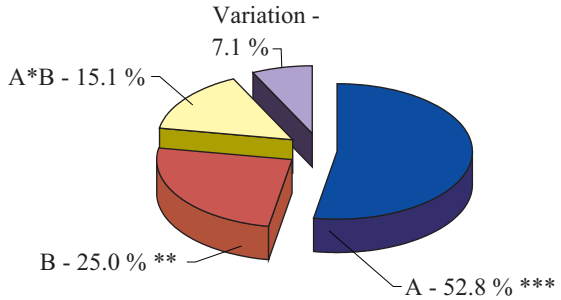

Fig. 2. Effect of Bio-product and growing scheme on the yield of variety Nikolina F_1

2014-2016 the early yield from variety Kopnezh F_1 in single-row scheme of growing varies from 1 047.1 kg/da to 1 540.9 kg/da (Table 1). The index of earliness is the highest for the plants treated with Emosan+Biofa (48.0%), followed by the variant treated with Emosan (46.0%), where the early yield exceeds the control with 49.5% and 39.9%, respectively. The differences between the variants towards the control are statisticallysignificant.

The results in variety Nikolina F_1 are the same like in variety Kopnezh F_1, and the yield obtained is higher. In single-row scheme of growing the treatments with combined application of Emosan+Biofa (54.0%) and Emosan (52.0%) are central. They exceed the control with 50.0% and 42.5%, respectively in statistically significant differences.

In two-row scheme of growing is observed the same tendency like in single-row. The index of earliness for the two varieties is lower (Table 2). The highest early yield is obtained from the plants, grown under background of Emosan+Biofa followed by the treatment with Emosan, where the increase towards the control for variety Kopnezh F_1 is 44.7% and 36.5%, and for variety Nikolina F_1 – 45.8% and 37.8%.

The positive effect of the bio-products on the early yield towards the control for the two varieties is proven as it is stronger expressed in single-row of growing. In single-row scheme of growing was established that the average effect of the bio-products for fertilization on the early yield is higher in variety Kopnezh F_1 – 36.1% towards 35.5% for variety e-row Nikolina F_1. In the double-row scheme of growing the results are identical in variety Kopnezh F_1 – 34.0% towards 32.3% for variety Nikolina F_1.

The results for the yields are the same with those ones obtained for the early yield. Statistically proven the highest yield in variety Kopnezh F_1, average for the period, was established on background Emosan-Biofa (3 320.5 kg/da), followed by those fertilized with Emosan (3 185.4 kg/da) and the increase towards the control plants is with 26.8% and 25.2%, respectively (Figure 3). The results obtained are statistically proven towards the control. The analogous results are also obtained for the variety Nikolina F_1.

Table 1
Economic productivity, single-row scheme of growing kg/da

№	Variants	Kopnezh F_1			Nikolina F_1		
		$\bar{x}$±sd	index of earliness%		$\bar{x}$±sd	index of earliness%	
1	Control	1047.1±45.1 d	40.0	100	1191.9±46.9 e	44.0	100
2	Biosol	1275.7±39.4 c	43.0	123.7	1435.3±35.3 d	46.0	120.4
3	Biosol + Biofa	1357.8±22.3 c	43.5	131.2	1520.3± 25.9 c	48.0	129.1
4	Emosan	1431.9±30.5 b	46.0	139.9	1638.6±61.4 b	52.0	142.5
5	Emosan+Biofa	1540.9±31.3 a	48.0	149.5	1787.6±30.2 a	54.0	150.0
Average effect				**136.1**			**135.5**

a,b,c,d,e – Duncan`s multiple range test ($p < 0.05$)

Table 2
Economic productivity, two-row scheme of growing – kg/da

№	Variants	Kopnezh F_1			Nikolina F_1		
		$\bar{x}$±sd	Index of productivity,%		$\bar{x}$±sd	Index of productivity,%	
1	Control	1164.1±39.1 d	38.0	100	1311.5±13.5 d	42.0	100
2	Biosol	1446.4±44.3 c	41.5	124.2	1545.6±45.6 c	44.0	120.3
3	Biosol + Biofa	1510.1±17.2 bc	42.0	130.8	1622.8±29.9 c	45.0	125.3
4	Emosan	1562.4±26.1 ab	44.0	136.5	1759.2 ±65.0 b	48.0	137.8
5	Emosan+ Biofa	1657.3±24.8 a	46.0	144.7	1871.5±41.7 a	50.0	145.8
Average effect				**134.0**			**132.3**

a.b,c,d, – Duncan`s multiple range test ($p < 0.05$)

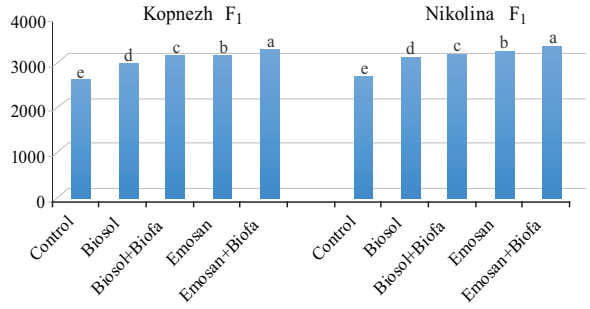

Fig. 3. Effect of fertilization on yield in single-row scheme
a,b,c,d,e – Duncan`s multiple range test ($p < 0.05$)

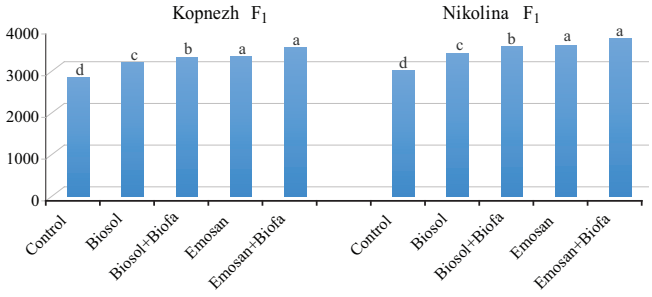

Fig. 4. Effect of fertilization on yield in two-row scheme
a,b,c,d – Duncan`s multiple range test ($p < 0.05$)

The average effect of the bio-products for fertilization on the yield in single-row scheme for growing is higher in variety Kopnezh F_1 – 21.1% towards 19.5% – for variety Nikoliona F_1.

It is observed that this tendency is kept in double-row scheme. The highest yield in variety Kopnezh F_1 is obtained in plants with treatment of Emosan+Biofa, followed by those plants treated with Emosan. The increase towards the control is with 21.2% and 23.7% respectively (Figure 4). The differenc-

Table 3
Index of productivity in variety Kopnezh F_1, 2014-2016

№	Variants	Mass fruit, g	Leaf stalk mass, g	Total vegetable mass, g	From her%		Index of productivity
					Fruit	Leaf stalk mass	
	Single-row scheme of growing						
1	Control	2074.7	756.4	2831.1	73.3	26.7	2.7
2	Biosol	2769.9	855.1	3625.1	76.4	23.6	3.2
3	Biosol+Biofa	2768.0	882.6	3739.8	74.0	23.6	3.1
4	Emosan	3019.8	903.3	3923.2	77.0	23.0	3.3
5	Emosan+Biofa	3262.2	920.7	4182.9	78.0	22.0	3.5
	Two-row scheme of growing						
1	Control	2036.9	697.6	2734.5	74.5	25.5	2.9
2	Biosol	2476.7	804.1	3280.7	75.5	24.5	3.1
3	Biosol+Biofa	2697.3	820.6	3517.9	76.7	23.3	3.3
4	Emosan	2872.6	848.2	3720.9	77.2	22.8	3.4
5	Emosan+Biofa	3026.8	863.2	3890.0	77.8	22.2	3.5

Table 4
Index of productivity in variety Nikolina F_1, 2014-2016

№	Variants	Mass fruit, g	Leaf stalk mass, g	Total vegetable mass, g	From her%		Index of productivity
					Fruit	Leaf stalk mass	
	Single-row scheme of growing						
1	Control	2370.7	710.7	3081.4	76.9	23.1	3.3
2	Biosol	2759.9	808.7	3568.6	77.3	22.7	3.4
3	Biosol+Biofa	2868.9	816.7	3685.6	77.8	22.2	3.5
4	Emosan	2998.8	833.6	3832.4	78.2	21.8	3.6
5	Emosan+Biofa	3198.8	851.6	4050.4	79.0	21.0	3.8
	Two-row scheme of growing						
1	Control	2001.5	636.3	2637.8	75.9	24.1	3.1
2	Biosol	2653.2	723.0	3376.2	78.6	21.4	3.7
3	Biosol+Biofa	2814.4	744.2	3558.6	79.1	20.9	3.8
4	Emosan	2978.7	755.0	3733.7	79.8	20.2	3.9
5	Emosan+Biofa	3013.9	777.4	3791.3	79.5	20.5	3.9

es between the two treatments are nor statistically significant. Identical results are also obtained for variety Nikolina F_1. The average effect of the bio-products for fertilization on the yield in double-row scheme is higher in variety Kopnezh F_1 – 19.4% towards 18.7% – for variety Nikolina F_1.

It is proven a positive effect for both varieties in application of the bio-products for fertilization on the yield towards the control but it is stronger expressed in the single-row scheme of growing. Data for the index of productivity are identical for the three years of the experiment. The highest index in variety Kopnezh F_1 is obtained in plants treated Emosan+Biofa (3.5) in both growing schemes where the yield is higher (Table 3). This index is higher in double-row scheme of growing.

The index of productivity in variety Nikolina F_1 is within 3.3-3.8 in single-row scheme (Table 4) as it is with the highest values in treatment with Emosan+Biofa (3.8). The tendency for higher values of this character in double-row scheme of growing is kept for variety NikolinaF_1 too – (3.9).

Conclusions

It is statistically proven that the factor Bio-product has stronger effect – 47.7% in yield formation for variety Kopnezh F_1 and 52.8% for variety Nikolina F_1 from the total variation, while the effect of the factor Scheme is more slight 34.8% and 25.0%, respectively.

A positive effect of bio-products on the early yield towards the control is proven for both varieties and it is stronger expressed in single-row scheme of growing. The highest early yield is obtained in plants treated with Emosan-Biofa, followed by those plants treated with Emosan for both varieties in the two growing schemes. The average effect of the bio-products for fertilization on the early yield is higher in variety Kopnezh F_1 – 36.1% towards 35.5% for variety Nikolona F_1 in single-row scheme of growing.

The applied bio-products for fertilization have a significant positive effect on the yield. In single-row scheme of growing the highest yield are obtained from the plants grown on a background Emosan+Biofa. The increase towards the control is with 26.3% (variety Kopnezh F_1) and 25.3% (variety Nikolina F_1). The average effect of applied bio-products is higher in variety Kopnezh F_1 (21.1%), compared to variety Nikolina F_1 (19.5%). It is proven that the effect of fertilization is stronger for both schemes of growing while the effect of the variety is weaker.

In combined treatment with the bio-products Emosan+Biofa, the index of productivity is higher in variety Nikolina F_1 3.8 – for single-row scheme and 4.0 – for double-row scheme of growing, respectively, where the yield is higher. In variety Kopnezh F_1 this index is 3.6 for the two growing schemes.

References

Aly, H. H., 2002. Studies on keeping quality and storageability of cucumber fruits under organic farming system in greenhouses. M.Sc. Thesis, *Fac. Agric., Cairo Univ.*, Egypt.

Antonova, G., 2012. Study on yield and quality characters in cabbage seed obtained in the conditions of organic trial. *Cruciferae Newsletter*, **31**: 22-25.

Antonova, G., S. Masheva and V. Yankova, 2012. Evaluation of head cabbage genotypes in the aspect of their use as initial material for organic breeding. *Cruciferae Newsletter*, **31**: 37-40.

Boteva, Hr., 2014, Quality of tomato seedling in application bioproducts. Turkish Journal of agricultural and natural sciences, **2** (167): 1665-1675.

Boteva, Hr. and T. Cholakov, 2010. Study on influence of biofertilizers for growing of tomato in field conditions. *Journal of International Scienctific Publications; Ecology&Safety*, **4**: 153-161.

Boteva, Hr. and O. Georgieva, 2013. Application of bioproducts to improve the quality of pepper seedlings. *Plant Sciece*, **50** (2): 38-42.

Dimov, I., 1983. Influence of rain intensity on vegetative and reproductive manifestations of pepper – medium production. Doctoral dissertation, *"Maritsa" Vegetable Crops Research Institute,* Plovdiv, Bulgaria.

Dimov, I., G. Antonova and B. Arnaudov, 2007. Effects of humustim on some tomatoes, cucumbers and cabbage. Humustim – a Gift from Nature, the Fertilizer of the Future. *Dimy 99 Ltd*., Sofia, 204.

Duncan, D., 1955. Multiple range and multiple F-test. *Biometrics*.; **11**: 1-42.

Lakin, G., 1990. Biometrics. *High School*, Moscow.

Nacheva, E., S. Masheva and V. Yankova, 2013. Characterization of agrobiological response of mid-early potato breeding lines and varieties in biological production. *Plant Science*, **50**: 80-85.

Panayotov, N., 2000. Introduction to Biologically Vegetable Production, Series "Biological Gardening" №1, *Agroecological Center, Agricultural University*, 68.

Poudel, D. D., W.R. Horwath, W.T. Lanini, S.R. Temple and A.H. Van Bruggen 2002. Comparison of soil N availability and leaching potential, crop yield and weeds in organic, low-input and conventional farming systems in Northern California. *Agric Ecosyst Environ*, 90: 125-137.

Rasool, A., P. S. Zivek and M. R. Satari, 2008. Effect of vermicompost on growt, yield and nutrition status of tomato (*Licopersicum esculentum*). *Pakistan Journal of Biological Sciences*, **11** (14): 1797-180.

Rembiałkowska E., 2000. The Health and Sensory Quality of Potatoes and Selected Vegetables from Organic Farms. *SGGW Publishing House*, Warsaw (Pl).

Shaheen., A. M., A. Fatma, R. Omiama, M. Sawan and A.A. Ghoname. 2007. The integrated use of bio-inoculants and chemical nitrogen fertilizer on growth, yield and nutritive value

of two okra (*Abelmoschus esculentus*, L.) cultivars. *Australian Journal of Basic and Applied Sciences*, **1** (3): 307-312.

Szafirowska, A. and I. Babik. 2005. Organic vegetables in studies of Research Institute of Vegetable crops. *Nowosci Warzywnicze*, **41**: 115-127.

Todorova, V., 2013. Evaluation of some quality characters of pepper organic seeds. International scientific-practical conference, Scientific support for Potato, Vegetable and Melon: achievements and perspectives, December 11-12, Kazakhstan, pp. 516-519.

Todorova, V., V. Yankova and St. Masheva, 2013. Manifestations of Bulgarian pepper varieties grown in conditions of organic production. *Plant Science*, **50** (2): 34-37 (Bg).

Tringovska, I. and V. Kanazirska, 2007. Effect of some organic fertilizers on plant growth and fruit yield of greenhouse tomatoes. Proceedings of the International Conference Research People and Actual Tasks on Multidisciplinary Sciences, 1: 32-36.

Vasileva, V., 2016. Influence of some agroecological factors on the early production, productivity and production quality of determinate varieties and hybrids of tomatoes. PhD., *"N. Poushkarov" Institute of Soil Science, Agrotechnology and Plant Protection, Sofia (Bg).*

Vasileva, V., N. Dinev and Iv. Mitova, 2015. Influence of potassium fertilization and variety characteristics on the total yield of tomatoes grown in different production directions. International Conference "Soil and Agro-Technology in a Changing World", Electronic Collection of Scientific Papers, Sofia, 264-271 *(Bg).*

Vlahova, V. and V. Popov, 2013a. Influence of the biofertiliser Seasol on yield of pepper (*Capsicum annuum* L.) cultivated under organic agriculture conditions. *Journal of Organic Systems*, **8** (2): 6-17.

Vlahova, V. and V. Popov. 2013b. Effect of biofertilisers on the vitamin c content in pepper fruit (*Capsicum annuum* L.), cultivated under the conditions of organic agriculture. *New Knowledge Journal of Science*, 126-133.

Received March, 3, 2017; accepted for printing September, 14, 2017