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ДОБИВ И ПРОДУКТИВНОСТ ПРИ ПИПЕР ПРИ ПОЛСКО БИОЛОГИЧНО ПРОИЗВОДСТВО

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Ключови думи:
биоторове
биологично земеделие
пипер
продуктивност
добив

Резюме

Целта на това проучване е да се изследва влиянието на подбраните биоторове върху продуктовия капацитет на пипер от сорт „Софийска капия”, отгледан в условията на биологично земеделие. Този експеримент се проведе от 2010 г. до 2011 г. на експерименталната площ на Агроекологичния център на Аграрен университет - Пловдив на алувиално-ливадна почва. Проучването включва биоторовете - Бонепрот, Лумбрикал, Байкал ЕМ-1У и Сисол, които принадлежат към списъка на разрешените биоторове в съответствие с НаредбаNo.889/2008 на ЕС. Под влияние на приложеното допълнително торене с течни торове, най-висок добив се съобщава за варианта подхранен с биотор Байкал ЕМ-1У върху основно торене с Лумбрикал - 2036 kg/da (2010) and 1893 kg/da (2011). Комбинираното приложение на биоторове върху основно торене има стимулиращ ефект върху добива при пипер.

YIELD AND PRODUCTIVITY OF PEPPER CULTIVATED UNDER THE CONDITIONS OF ORGANIC FARMING

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Key words:
biofertilisers
organic agriculture
productivity
pepper
yield

Abstract

The objective of this research was to examine the influence of selected biofertilisers on the production capacity of pepper of the variety of „Sofiiska kapiya” cultivated under the conditions of organic agriculture. This experiment was carried out from 2010 until 2011 on the experimental field of the Agroecological Centre at the Agricultural University - Plovdiv on the alluvial-meadow soil. The study included biofertilisers - Boneprot, Lumbrical, Baikal EM-1Y and Seasol, which belong to the list of permitted biofertilisers in accordance with the EU Regulation (EC) No. 889/2008. Under the impact of the applied additional fertilisation with liquid biofertilisers, the highest yield was reported for the variant fed with the biofertiliser Baikal EM-1Y on the basic fertilisation Lumbrical - 2036 kg/da, and 1893 kg/da (2011). The combined application of the biofertilisers on the basic fertilisation had a stimulating effect on the pepper yield.

Introduction

Organic farming is developing dynamically in Europe and worldwide (Sobieralski *et al.*, 2013) and is one among the longest spectrum in production methods that are supportive of the environment (Narkhede *et al.*, 2011; Popov, 2013; Arabska, 2013). Todorova and Filyova (2014) point out that Costel and Vasile (2012) found that organic farming is a modern way of agriculture management, not using any chemical plant protection and mineral fertilization which have negative effects on the environment, human and animal health.

The term biofertilizers includes selective microorganism like bacteria, fungi and algae (Aggani, 2013). Biofertilizers are formulations of beneficial microorganisms, which upon application can increase the availability of nutrients by their biological activity and help to improve the soil health (Agamy *et al.*, 2013). Biofertilizers are used in live formulation of beneficial microorganism which on application to seed, root or soil, mobilize the availability of nutrients particularly by their biological activity and help to build up the lost microflora and in turn improve the soil health in general (Ismail *et al.*, 2013). Liquid fertilizers derived from seaweeds are found to be superior to chemical fertilizers (Padhi and Swain, 2009).

Pepper (*Capsicum annuum* L.) ranks among the most important vegetable crops worldwide (Długosz, 2012).

The objective of this research was to examine the influence of selected biofertilisers on the production capacity of pepper of the variety of „Sofiiska kapiya" cultivated under the conditions of organic agriculture.

Material & methods

This experiment was carried out from 2010 until 2011 on the experimental field of the Agroecological Centre at the Agricultural University- Plovdiv on the alluvial-meadow soil. The research included pepper of the variety Sofiiska Kapiya, cultivated under organic agriculture conditions.

Pepper is a very exacting crops regarding the predecessor and very suitable predecessors are the vegetable varieties from the Family *Fabaceae* and the Family *Cucurbitaceae* (Panayotov at al., 2007).

The seedlings were planted on a permanent place during the third decade of May, on a high levelled seed- bed (scheme 120 + 60 x 15 cm), according to the method of long plots, into 3 repetition, with a size of the test plot of 9,6 m^2. Irrigation was carried out via a drop irrigation installation.

Variants: 1. Control (non- fertilised); 2. Basic fertilisation with Lumbrical + Seasol; 3. Basic fertilisation with Lumbrical + Baikal EM- 1Y; 4. Basic fertilisation with Boneprot + Seasol; 5. Basic fertilisation with Boneprot + Baikal EM- 1Y.

The study included biofertilisers- Boneprot, Lumbrical, Baikal EM- 1Y and Seasol, which belong to the list of permitted biofertilisers in accordance with the EU Regulation (EC) No. 889/2008.

Boneprot (Arkobaleno, Italy) is a pellet organic fertilizer, consisting mostly of cattle manure and has following composition: organic nitrogen (N) - 4,5%; phosphorus anhydride (P_2O_5) – total - 3,5%; potassium (K_2O) - 3,5%; calcium (CaO) - 5- 8%; magnesium (MgO) -0,8- 1%; organic carbon (C) of biological origin- 30%; humification rate (HR) - 10-13%; degree of humification (DH)- 40- 42%; humification index (HI) - 1,3 - 1,4%; humidity - 13 - 15%; pH in water- 6 - 8.

Lumbrical (v. Kostievo - Plovdiv, Bulgaria) is a product obtained from the processing of natural fertiliser and other organic waste of the Californian red worms (*Lumbricus rubellus* and *Eisenia foetida*) and consists of their excrements. The commercial product has humidity of 45 - 55% and organic substance content of 45-50%. Ammonium nitrogen (NH_4N) - 33,0 ppm; nitrate nitrogen (NO_3N) - 30,5 ppm; P_2O_5 - 1410 ppm; K_2O - 1910 ppm, MgO - 1,8%. It contains useful microflora $2x10^{12}$ pce/g, huminous and fulvo acids, nutritional substances. The product has an activity of 6,5-7,0 (pH in H_2O).

Baikal EM-1Y (Ukraine) include effective microorganisms (EM), a large group of microorganisms living under a regime of activity upon interaction with the nutritional environment, etc. Bacterial inoculation includes *Lactobacillus casei*, *Lactobacillus lactis*, *Rhodopseudomonas palustris,* and *Saccharomices cerevisiae*. The product has the following chemical composition: organic carbon (C) - 0,15%; total nitrogen - 0,01%; total phosphorus (such as P_2O_2) - 0,001%; total potassium (K_2O) - 0,02 %.

Seasol (Earthcare, Australia) is a 100 % liquid natural seaweed extract of brown algae *Durvillaea potatorum*. The commercial product contains: raw protein (2,5±0,1% w/w); alginates (6±2% w/w); total solidity (10,0±0,5% w/w) and has a variety of mineral elements and traces of Ca (0,05±0,03% w/w), Mg (0,01±0,005 % w/w), N (0,10±0,05% w/w), P (0,05±0,02 % w/w), K (2,0±0,5% w/w) and has pH (10,5±0,5% w/w).

Fertilisation

The pepper seeds were infused in the bioproducts - Baikal EM-1Y and Seasol, as for Baikal EM-1Y the ratio was 1: 100 (1 ml Baikal EM- 1Y in 100 ml H_2O) for 2 hours, and for Seasol the ratio was 1:500 for 3 hours.

Two basic fertilisations were used, namely: Boneprot and Lumbrical. They were applied into the soil through incorporation prior planting of the seedlings on the field in concentration - 35 kg/da for the Boneprot and 200 L/da for the Lumbrical.

During the vegetation the liquid biofertilisers Baikal EM-1Y and Seasol were introduced into the soil as feeding, two times - at the flower - bud stage and at the mass fruitfulness stage, in concentrations of Baikal EM-1Y -1:1000, and 0,3-0,4 L/da for Seasol.

Study Indicators:
1. Standard Yield (kg/da);
2. Economic productivity of plants: number of fruits per plant- (pcs/plant) 10 plants per treatment were analyzed and mass of fruits (g)- 10 fruits per treatment were analyzed.
3. Mathematical data processing used MS Office Excel 2007 and SPSS (Duncan, 1955). A Duncan multiple-range test was also performed to identify the homogeneous type of the data sets among the different treatments.

Results & discussion

Standard Yield

Yield is an important indicator for the activity of applied biofertilisers. In the experimental year of 2010 express dynamics of the standard yield was reported for the pepper of the variety of "Sofiiska kapiya" (Table 1). Under the impact of the applied additional fertilisation with liquid biofertilisers, the highest yield was reported for the variant fed with the biofertiliser Baikal EM-1Y on the basic fertilisation Lumbrical - 2036 kg/da, as the yield increase as compared to the non- fertilised control was by 44,9%. The second most effective tested variant was the biofertiliser Baikal EM-1Y applied on the basic fertilisation Boneprot – 2015 kg/da, where the increase as compared to the non-fertilised control was by 43,4%.

The combined application of the biofertilisers on the basic fertilisation had a stimulating effect on the pepper yield. A very good effect on the yield was reported for the combination of the biofertiliser Seasol on the basic fertilisation Lumbrical - 1942 kg/da, as the increase comparing to the non-fertilised control was by 38,2%. It was established that the combination of the biofertilisers Boneprot and Seasol has a positive effect on the yield increase, which was due to the result of the additionally applied biofertiliser Seasol containing auxins and alginates, as well as due to the activity of the biofertiliser Boneprot applied as a basic fertilisation, where nutritional substances were slowly released during the vegetation and the plants gradually acquired them.

In the experimental year of 2011, under the influence of applied biofertilisers, some variation from the standard yield was reported, as the increase of the non-fertilised control on the basic fertilisation Boneprot was by 21,2% to 29,8%, and on the basic fertilisation Lumbrical - by 23,0% to 33,3%. The highest yield was reported for the treatment fed with the biofertiliser Baikal EM-1Y on the basic fertilisation Lumbrical - 1893 kg/da, followed by the treatment fed with the biofertiliser Baikal EM-1Y on the basic fertilisation Boneprot - 1844 kg/da, thus confirming that the combined application of the biofertilisers provided an opportunity for the plants during the vegetation period to be provided on a balanced principle with nutritional substances, thus supporting the better productivity of the pepper (Table 1).

Stimulating effect on the standard yield was reported after additional feeding with the biofertiliser Seasol on the basic fertilisation Lumbrical - 1747 kg/da, which confirmed the positive combination of influence of both biofertilisers as a result of the seaweed extract of the biofertiliser Seasol and of the basic fertilisation Lumbrical, which was characterized with the rich content of organic substance 45-50%.

Table 1. Standard Yield of plants, variety of Sofiiska kapiya (kg/da)- 2010 and 2011

Year		Control	Basic fertilization with Boneprot		Basic fertilization with Lumbrical	
			+ Baikal EM- 1Y	+ Seasol	+ Baikal EM- 1Y	+ Seasol
2010	mean St. Dev.	1405 ± 260.99 ^{b}	2015 ± 127.88 ^{a}	1884 ± 89.90 ^{a}	2036 ± 64.93 ^{a}	1942 ± 55.02 ^{a}
	Relative Yield (%)	100	43.4	34.1	44.9	38.2
2011	mean St. Dev.	1420 ± 40.95 ^{d}	1844 ± 53.63 ^{ab}	1721 ± 55.76 ^{c}	1893 ± 102.08 ^{a}	1747 ± 42.67 ^{bc}
	Relative Yield (%)	100	29.8	21.2	33.3	23.0
Average for the period		1412.5	1929.5	1802.5	1964.5	1844.5

a,b,c,d – Duncan's Multiply Range Test, P<0,05

Economic productivity of plants

The biggest number of fruits per plant was reported for the variant with soil feeding with the biofertiliser Baikal EM-1Y on the Lumbrical basic fertilisation, as the increase compared to the control was by 56% (2010) and 51,9% (2011), and their average number for the period was increased by 7,8 pcs/plant (Table 2) Biofertilisers had a significant impact on the total number of fruits per plant for all variants in comparison with the non-fertilised control, as the results obtained were identical to those reported throughout two years.

Table 2. Economic productivity of plants, variety of Sofiiska kapiya (kg/da)- 2010 and 2011

	Year	Control	Basic fertilization with Boneprot		Basic fertilization with Lumbrical	
			+ Baikal EM-1Y	+ Seasol	+ Baikal EM-1Y	+ Seasol
Number of fruits	2010	5.0 ± 0.500 ^{c}	7.1 ± 0.601 ^{b}	6.7 ± 0.500 ^{b}	7.8 ± 0.441 ^{a}	6.9 ± 0.601 ^{b}
	2011	5.2 ± 0.441 ^{c}	7.7 ± 0.500 ^{ab}	7.6 ± 0.527 ^{ab}	7.9 ± 0.601 ^{a}	7.1 ± 0.601 ^{b}
Average for the period		5.1	7.4	7.1	7.8	7.0
Mass of fruits	2010	65.3 ± 1.102 ^{c}	75.8 ± 0.416 ^{a}	67.8 ± 1.848 ^{b}	76.2 ± 1.102 ^{a}	69.4 ± 1.000 ^{b}
	2011	63.1 ± 1.115 ^{c}	73.8 ± 0.252 ^{a}	67.9 ± 0.529 ^{b}	74.4 ± 0.666 ^{a}	67.5 ± 1.323 ^{b}
Average for the period		64.2	74.8	67.8	75.3	68.4

a,b,c,d – Duncan's Multiply Range Test, P<0,05

The highest value of the mass of the fruits was reported upon feeding with Baikal EM-1Y on the Lumbrical basic fertilisation - 76,2 g (2010) and 74,4 g (2011), which determined the stimulating effect of combined application of the biofertilisers. This was due to the higher content of huminous and fulvo acids on the Lumbrical basic fertilisation, as well as to the microflora additionally introduced via the biofertiliser Baikal EM - 1Y.

The feeding with biofertilisers had influence on the elements of the yield, which to a great extent was determined by the number and the mass of the fruits.

Conclusion

The additional vegetative feeding with biofertilisers resulted in the increased yield of pepper plants. Our research findings that biofertilisers increase the mass and the number of the fruits.

It was established that the additional feeding with the microbial biofertiliser Baikal EM-1Y had the strongest impact on the yield, regardless of the applied basic fertilisation, as the better combination was proven to be the biofertiliser Baikal EM-1Y on the basic fertilisation Lumbrical and the increase compared to the non - fertilised control was by 44,9% (2010); 33,3% (2011).

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