

**IMPACT OF BIOFERTILISERS UPON QUALITY PARAMETERS OF PEPPER FRUITS
(CAPSICUM ANNUUM L.) CULTIVATED UNDER THE CONDITIONS OF ORGANIC
AGRICULTURE**

Veselka N. Vlahova, Vladislav H. Popov

Agricultural University - Plovdiv, 12 Mendelev Blvd., 4000 Plovdiv, Bulgaria

Department of Agroecology and Protection of Agroecosystems and Population

Abstract

Organic agriculture is one of the most promptly developing fields of agriculture on a worldwide scale. Biofertilisers have been identified as an alternative to chemical fertilisers to increase soil fertility and crop production in sustainable farming. This experiment was carried out in 2009 - 2011 on the experimental fields of the Agroecological Centre at the Agricultural University - Plovdiv. The aim of the study was to examine the impact of the fertilisation on the quality parameters of the pepper "Sofiiska Kapiya" (dry matter, total sugars and vitamin C). This study includes the following biofertilisers - Boneprot (Arkobaleno), Lumbrical and Emosan (HemoZym) which are included in the list of the permitted substances according to Regulation (EC) No. 889/2008. During the experimental period, upon comparison of the combined variants on both basic fertilisations, a positive effect on the quality of the fruits was detected after application of the biofertiliser Emosan on the Lumbrical basic fertilisation, as it increased the dry matter (2009, 2010, 2011), sugars (2009, 2010) and vitamin C (2010, 2011), thus confirming this combination as successful for application in the bioproduction of pepper. The application of Emosan on both basic fertilisations determined the benefit of the application of biofertilisers for the purpose of obtaining good quality and healthy production.

Key words: *Capsicum annuum* L., organic agriculture, biofertilisers, quality, biochemical parameters

1. INTRODUCTION

Organic agriculture is one of the most promptly developing fields of agriculture on a worldwide scale (Svobodkov, 2002). Topalov et al. (1993) points out that Bulgaria has unique agroecological conditions for development of efficient environmentally - friendly agriculture. Organic agriculture is realised in production units - organic farms (Karov et al., 1998).

Biofertilisers are inputs containing microorganisms which are capable of mobilizing nutritive elements from unusable form to usable form through biological processes (Shaheen et al., 2007). Biofertilisers have been identified as an alternative to chemical fertilizer to increase soil fertility and crop production in sustainable farming (Wu et al., 2005; Marozsán et al., 2009). It is important that organically grown crops are highly nutritional, have better sensory taste and have high functional properties (Baswana and Rana, 2007).

In recent decades the high biological value and the excellent gustatory and technological properties of pepper fruits have made this vegetable culture even more important (Cholakov et al., 1996). Fruits and vegetables of bioproduction are characterized with a high content of vitamins, antioxidants and flavonoids. Authors point out that several organically cultivated varieties of pepper have shown a higher content of vitamin C and flavonoids (Szafirowska and Elkner, 2008; Szafirowska and Elkner, 2009). Red pepper (*Capsicum annuum*) is among the products with quality dependency on drying conditions

(Alves- Filho et al., 2007). The total sugars contained in the long fleshy red pepper are an element of the nutritional value of fruits and affect their gustatory properties (Pevicharova et al., 2007).

Objectives

The aim of the study was to examine the impact of the fertilisation applied (as basic fertilisation and as combination feeding) on the quality parameters of the pepper “Sofiiska Kapiya” (dry matter, total sugars and vitamin C).

2. MATERIALS AND METHODS

This experiment was carried out in 2009 - 2011 on the experimental fields of the Agroecological Centre at the Agricultural University - Plovdiv, situated on the territory of the certified ecological farm.

Treatments:

1. Control (non-fertilised)
2. Basic fertilisation with Boneprot (optimum concentration)
3. Basic fertilisation with Boneprot (50 %) + Emosan
4. Basic fertilisation with Lumbrical (optimum concentration)
5. Basic fertilisation with Lumbrical (50 %) + Emosan

Fertilisation

Two basic fertilisations were used, namely: Boneprot and Lumbrical, applied into the soil through incorporation prior planting of the seedlings on the field. The biofertilisers were applied in two concentrations - optimum (corresponded to 70 kg/da for the basic fertilisation with Boneprot and 400 L/da for the basic fertilisation with Lumbrical) and reduced by 50 %. Biofertiliser Emosan was introduced as a soil amendment during the vegetation at the plant growing stage ‘flower bud’ and ‘mass fruitfulness’ in concentration 15 L/ da.

2.1. Materials

Vegetable tested

The research included pepper of the variety of “Sofiiska Kapiya” cultivated as mid - early field production according to the principles of organic agriculture (Panayotov, 2000).

2.2. Characteristics of the biofertilisers included into the study

This study includes the following biofertilisers - Boneprot (Arkobaleno), Lumbrical and Emosan (HemoZym) which are included in the list of the permitted substances for soil maintaining fertility according to Regulation (EC) No. 889/2008 (Enclosure No. 1).

Boneprot (Arkobaleno, Italy) it is pellet organic fertilisers, and has the 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. Boneprot is an entirely organic fertiliser consisting exclusively of cattle manure. These materials are collected from farms which do not use antibiotics and are subject to controlled fermentation for a period of about one year.

Lumbrical (v. Kostievo- Plovdiv, Bulgaria) is a product obtained from the processing of natural organic manure and other organic waste by the Californian red worms (*Lumbricus rubellus* and *Eisenia foetida*)

and consists of their excrements. The commercial product has humidity of 45-55 % and organic matter content of 45-50 %. Ammonium nitrogen (NH_4N)-33,0 ppm; nitrate nitrogen ($\text{NO}_3\text{-N}$)-30,5 ppm; P_2O_5 and K_2O -respectively 1410 ppm and 1910 ppm, MgO - 1,8 %. It contains useful microflora 2×10^{12} pce/g, humic and fulvic acids, nutritional matters. The product activity is 6,5- 7,0 (pH in H_2O).

Emosan, HemoZym NK (Arkobaleno, Italy) contains total nitrogen (N) - 5 %; organic nitrogen (N) - 5 %; organic carbon (C) of biological origin - 14 %; protein - 34 p/p; humidity - 65 p/p; K - 0,4 p/p; P - 0,06 p/p, etc.; pH -7,0 - 10,0. It is intended for organic agriculture by virtue of MiPAF Circular No. 8 of 13 September 1999 of the EU.

The plants were cultivated from seedlings in a polyethylene greenhouse. The seedlings were planted on a permanent place during the third decade of May, on a high-leveled seed - bed, according to the planting scheme $120 + 60 \times 15$ cm. The experiment was done according to the method of long plots, into four replications, with a size of the test plot of 9,6 m^2 . Irrigation was carried out via a drop irrigation installation.

2.3. Study Parameters

2.3.1. Production quality - biochemical analysis was carried out on an average sample of 20 fruits from each treatment. Following parameters were observed: dry matter (refractometrically - %), vitamin C (acc. to Tilman's reaction - mg %) and total sugars (according to Schoorl - Regenbogen) (Genadiev et al., 1969).

3. RESULTS AND DISCUSSION

3.1. Quality of Pepper Bioproduction

The Figure 1 below presents the main biochemical parameters detected in the research (dry matter, total sugars and vitamin C) from 2009.

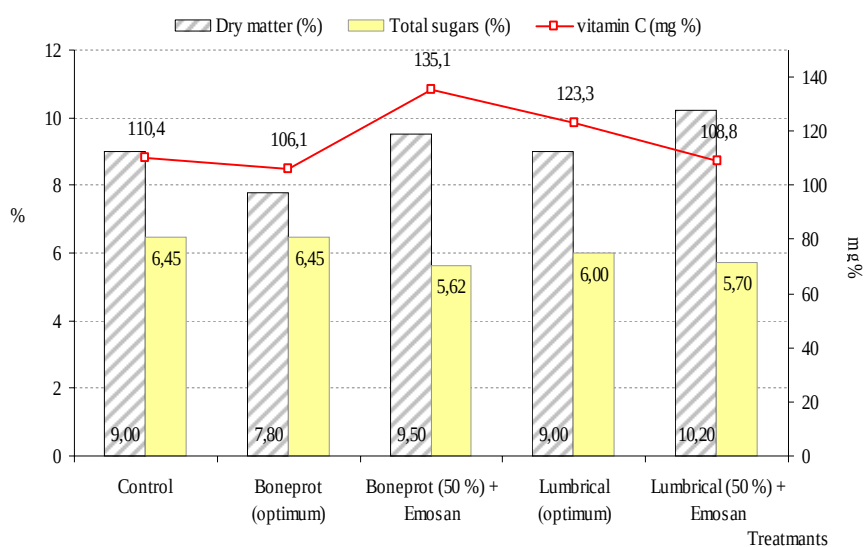


Figure 1. Content of vitamin C, total sugars and dry matter in the fruits of the variety of “Sofiiska Kapiya” - 2009

The research found that the contents of dry matter were the highest in the fruits of the variant treated with the biofertiliser Emosan applied on the Lumbrical basic fertilisation - 10,20 %. A very good value was reported upon the application of the biofertiliser Emosan on the Boneprot basic fertilisation - 9,50 %. The combined application of the biofertiliser Emosan on both basic fertilisations had a positive effect on the increase of the contents of dry matter, in comparison with the single application of basic fertilisations.

It was found that there was a change in the contents of total sugars under the impact of the applied fertilisation. The highest value was detected for the fruits of the plants of the variant with an optimum concentration of the Boneprot basic fertilisation. Upon comparison of the effect of the combined treatment on both basic fertilisations, higher results were detected upon the application of the biofertiliser Emosan on the Lumbrical basic fertilisation.

The results from the biochemical analyses showed a highest value of vitamin C content for the fruits of the variant treated with the biofertiliser Emosan on the Boneprot basic fertilisation - 135,1 mg%. This increase can be explained with the nature and content of the biofertilisers and with the suitable combination between them. A good value was reported for the fruits of the plants grown on the Lumbrical basic fertilisation applied in optimum concentration, i.e.123,3 mg%.

In 2010 the results of the biochemical analysis showed that the dry matter contents in the fruits of the pepper plants were the highest after the Boneprot basic fertilisation in optimum concentration- 8,80 % and it can be attributed to the nature of this biofertiliser (Fig. 2). Upon comparison of the values of the combined variants on both basic fertilisations, the higher values were reported for the biofertiliser Emosan on the Lumbrical basic fertilisation.

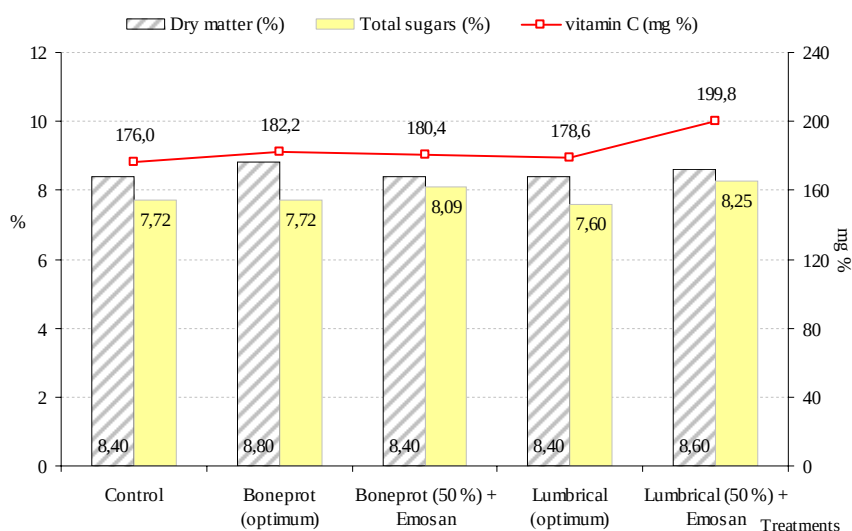


Figure 2. Contents of vitamin C, total sugars and dry matter, the variety of “Sofiiska Kapiya” - 2010

The highest value of the contents of total sugars in the pepper fruits was reported for the soil treated with the biofertiliser Emosan on the Lumbrical basic fertilisation - 8,25 %, followed by the variant with the same biofertiliser on the Boneprot basic fertilisation. The highest results showed by pepper fruits after the combined application of Emosan on the Lumbrical basic fertilisation confirmed the findings obtained in 2009. The variants with combined biofertilisers showed higher values compared to the

variants with single optimum concentrations which determined the positive effect of the combined fertilisation on the total sugars.

The highest values of vitamin C were reported for the fruits of the variant treated with the biofertiliser Emosan on the Lumbrical basic fertilisation - 199,8 mg%. High values were also shown after application of biofertiliser Emosan on Boneprot basic fertilisation - 180,4 mg%. The results showed that the combined fertilisation with the biofertiliser Emosan on the Lumbrical basic fertilisation had positive effect on the vitamin C contents of the pepper fruits, it also exceeded the values shown after application of optimum concentration of basic fertilisations.

In 2011 that the plants fed with the biofertiliser Emosan on the Lumbrical basic fertilisation had the highest contents of dry matter in the fruits - 9,00 %, as the values of all variants exceeded the control - 7,20 %, which proved the stimulating effect on the tested biofertilisers. It was found that upon additional treatment with the biofertiliser Emosan the contents of dry matter in the fruits was higher in comparison with both basic fertilisations applied in optimum concentrations, which was similar to the result from 2009 (Fig. 3).

The highest value of contents of total sugars was reported in the fruits of the variant treated with the biofertiliser Emosan on the Boneprot basic fertilisation - 7,80 %. The total sugars after the combined application of biofertilisers were higher in comparison with the single application of basic fertilisations in optimum concentration of the Lumbrical basic fertilisation, which confirmed the result from 2010. The results on the Boneprot basic fertilisation were identical in all three years of experiments.

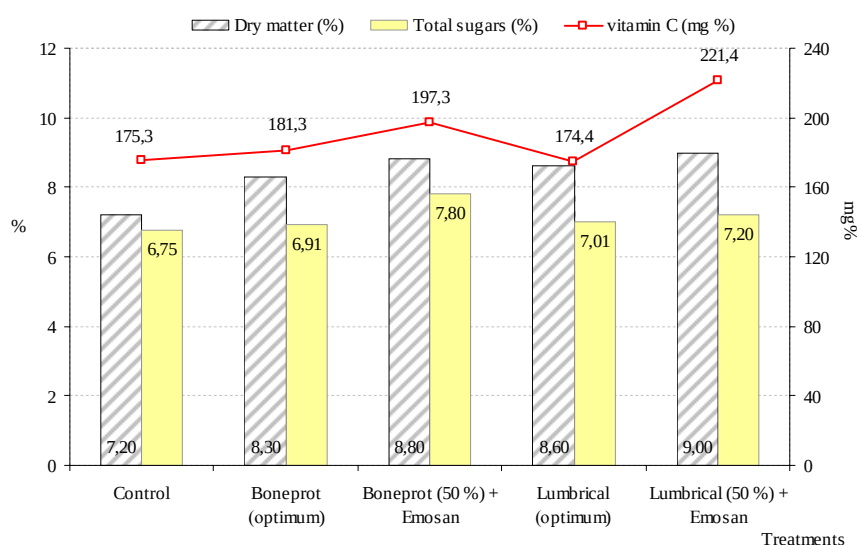


Figure 3. Contents of vitamin C, total sugars and dry matter in the fruits of the variety of "Sofiiska Kapiya" - 2011

It was found that there was an increase in the vitamin C contents in the pepper fruits. The increase depends on the applied fertilisation, as the values of all variants exceeded the control, which confirmed the findings obtained in 2010 (except for Lumbrical in optimum concentration- 2011).

The results showed that the highest vitamin C value was found in the fruits of the plants after fertilisation with the biofertiliser Emosan on the Lumbrical basic fertilisation - 221,4 mg%. A positive effect on the

vitamin C contents of the pepper fruits was reported for the variant fed with the biofertiliser Emosan on the Boneprot basic fertilisation - 197,3 mg%, which confirmed the result from 2010. This increase was due to the favourable combination of the biofertilisers and their nature, as the Boneprot basic fertilisation provided nutrients, which were released for a longer period during the pepper vegetation, and the biofertiliser Emosan was impacting the level of proteins contained in the biofertiliser.

Throughout the experiment the combined application of the biofertiliser Emosan on the Lumbrical basic fertilisation (2009, 2011) had a positive effect on the increase of the dry matter content of the fruits. Similar results were shown after Emosan on the Boneprot basic fertilisation (2009, 2011).

The combined application of the biofertiliser Emosan had also a positive effect on the increase of the total sugar content, as higher values were reported on the Lumbrical basic fertilisation (2009, 2010), and on the Boneprot basic fertilisation (2011). The combined application of the biofertiliser Emosan on both basic fertilisations had better effect than the optimum concentrations (2010,2011), which determined the benefit of the combined application of biofertilisers on a basic fertilisation.

The highest effect on the vitamin C contents in the fruits was reported after application of the biofertiliser Emosan on the Lumbrical basic fertilisation in the variety of "Sofiiska Kapiya" (2010, 2011), thus confirming the beneficial combination of the two biofertilisers. A good effect on the vitamin C contents was reported for the biofertiliser Emosan on the Boneprot basic fertilisation (2009, 2010, 2011). The application of Emosan on both basic fertilisations determined the benefit of the application of biofertilisers for obtaining good quality and healthy production.

Our research confirmed the findings of Boteva and Cholakov (2011) on the existence of more significant changes in the content of vitamin C in pepper fruits after application of biofertiliser Emosan, regardless of the basic fertilisation (in their research Montera and Lumbrical).

CONCLUSIONS

1. The highest impact on the dry matter contents in the pepper fruits was reported upon treatment with the biofertiliser Emosan on the Lumbrical basic fertilisation - 10,20 % (2009) and 9,00 % (2011).
2. The total sugar values of upon the combined application of biofertilisers were higher in comparison with the single application of basic fertilisations in optimum concentration on the Lumbrical basic fertilisation (2010, 2011), and on the Boneprot basic fertilisation (2009, 2010, 2011).
3. The variants including combined treatments of Emosan showed higher values of vitamin C than the treatments with optimum concentration on the Boneprot basic fertilisation (2009, 2011), and on the Lumbrical basic fertilisation (2010, 2011), thus determining the benefit of the combined application of biofertilisers for obtaining good quality organic produce.
4. During the experimental period, upon comparison of the combined variants on both basic fertilisations, a positive effect on the quality of the fruits was reported after application of the biofertiliser Emosan on the Lumbrical basic fertilisation, as it increased the values of the dry matter (2009, 2010, 2011), total sugars (2009, 2010) and vitamin C (2010, 2011), thus confirming this combination as successful for application in the organic pepper production.

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