Scientific Papers. Series B, Horticulture. Vol. LVIII, 2014
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE IMPACT OF BIOFERTILISERS ON THE QUALITY PARAMETERS OF THE PEPPER FRUIT (*CAPSICUM ANNUUM* L.) IN ORGANIC AGRICULTURE CONDITIONS

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Abstract

Organic agriculture, as a way of thinking and practice, originated in the first years of the XX century upon the application of various alternative methods of agricultural production. This experiment was carried out in 2009- 2011 on the fields of the Agroecological Centre at the Agricultural University - Plovdiv, situated on the territory of the certified ecological farm. The research included pepper variety 'Sofiiska Kapiya' cultivated as mid- early field production according to the principles of organic agriculture. The following biofertilisers were tested: Seasol (Earthcare), applied on two basic fertilisations, namely: Boneprot and Lumbrical. The objectives of the study were to establish the impact of biofertilisers on the quality parameters of the pepper fruits (dry matter, total sugars and vitamin C). The dry matter content of pepper fruits showed the highest values in 2009 and 2011, when the average for the period was 8,87 % and was shown by the variant fed with the biofertiliser Seasol on basic fertilisation Lumbrical. The total sugar content in the pepper fruits showed a maximum value of 7,22 % as the average for the study period and after application of the biofertiliser Seasol on the basic fertilisation Lumbrical. The combined application of the biofertiliser Seasol on the two basic fertilisations showed higher values of the total sugars in comparison with the single application of the basic fertilisations in optimum concentrations. The average for the period vitamin C content in fruits showed highest value upon application of the biofertiliser Seasol on the basic fertilisation Boneprot, i.e. 159,2 mg%, thus determining this combination as useful for vegetative feeding. The values of all treatments exceeded the control, thus confirming the beneficial impact of biofertilisers with respect to the improvement of pepper quality under organic management.

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

INTRODUCTION

Nowadays, organic agriculture is the synonym of a modern and contemporary production system, and biological products are the standard for healthy and quality food (Semos, 2002). Organic agriculture approach aims at establishing an integrated, ecological and economically sustainable system for the production of agricultural products (Stacey, 2003). The first documented use of the term "organic farming" was by Lord Northbourne in his London-published 1940 book *Look to the Land* (Paull, 2008).

In recent years there has been a significant increase in the demand for high quality fruit and vegetables (Vlahova, 2006). The great importance and distribution of pepper are due to its high biological value and the possibilities for its various use, both fresh and processed (Cholakov, 2009). Red pepper (*Capsicum annuum* L.) 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). Pepper fruits obtained from organic cultivation system comprised higher amount of vitamin C, beta-carotene and total flavonoids (Szafirowska and Elkner, 2008). Vlahova et al., (2011) show that according to Salami (2002) and Narayan et al. (2009) pepper contains a number of nutritionally-important compounds such as vitamin C and other mineral nutrients.

The research on the impact of biofertilisers on the quality of the pepper fruits cultivated in a ecological farm are relatively limited in

Bulgaria. However, such results are needed for the popularization of the advantages of organic pepper production, in view of ensuring quality and underlining the advantages of organic agricultural system.
The objectives of the study were to identify the impact of biofertilisers on the quality parameters (i.e. dry matter, total sugars and vitamin C) of pepper cultivate under organic farming.

MATERIALS AND METHODS

This experiment was carried out in 2009-2011 on the experimental fields of the Agroecological Centre at the Agricultural University - Plovdiv (Bulgaria), situated on the territory of the certified ecological farm.
Pepper is an annual crop and belongs to the Genus *Capsicum* of Family *Solanaceae.* The research included pepper of the variety 'Sofiiska Kapiya' used for average early and late field production (Panayotov, 2000).
Treatments:
1. Control (non-fertilised)
2. Basic fertilisation with Boneprot (optimum)
3. Basic fertilisation with Boneprot (50 %) + Seasol
4. Basic fertilisation with Lumbrical (optimum)
5. Basic fertilisation with Lumbrical (50 %) + Seasol

Two basic fertilizations were used, namely Boneprot and Lumbrical, applied into the soil through incorporation prior to planting of the seedlings on the field. The biofertilisers were applied in two concentrations - optimum (corresponded to 70 kg/da for the basic fertilization Boneprot and 400 L/da for the basic fertilization Lumbrical) and reduced by 50 %.
Liquid biofertiliser Seasol was introduced as a soil amendment in concentration 1:500- 0.3-0.4 L/da during the vegetation at the plant growing stage 'flower-bud' and 'mass fruitfulness'.
The seedlings were planted on a permanent place during the third decade of May, on a high levelled seed-bed, according to the scheme 120+60x15 cm.
The experiment was worked out according to the method of long plots, into four replications, with a size of the test plot of 9.6 m^2.
Characteristics of the biofertilisers included into the study. This study includes the following biofertilisers: Boneprot, Lumbrical and Seasol (Earthcare), which are included in the list of the biofertilisers 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 %; Humidity- 13-15%; pH in water- 6-8. Boneprot is an entirely organic fertiliser consisting exclusively of Cattle manure.
Lumbrical (Plovdiv, Bulgaria) is a product obtained from the processing of natural fertilizer 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 and K_2O-respectively 1410 ppm and 1910 ppm, MgO- 1.8%.It contains useful microflora $2x10^{12}$ pce/g, humic and fulvic acids, nutritional substances. The product has activity of 6.5- 7.0 (pH in H_2O).
Seasol (Earthcare) Seasol International Pty Ltd. (Australia) – an extract of brown algae *Durvillaea potatorum*. Seasol is a 100 % liquid natural seaweed extract. It contains 60 % of alginic acids. The commercial product contains as follows: raw protein (2.5 ± 0.1 % w/w); alginates (6 ± 2 % w/w); total solidity (10.0 ± 0.5 % w/w), and pH (10.5 ± 0.5% w/w), and has a variety of mineral elements and traces of Ca (0.05 ± 0.03 % w/w), N (0.10 ± 0.05 % w/w), P (0.05 ± 0.02 % w/w), K (2.0 ± 0.5 % w/w), Cu (0.3 ± 0.2 % w/w), and cytokines.

Study of parameters

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).

Statistical Analysis

All data were analyzed by using Duncan's multiple range test (Duncan, 1955) at the $P<0.05$ level. Differences between mean values were evaluated by a one-way analysis of variance (ANOVA) (SPSS treatment 7.5).

RESULTS AND DISCUSSION

Quality of organic pepper production

The data on the biochemical content of pepper fruits of the variety of 'Sofiiska Kapiya' are presented in Figure 1, 2 and 3 below.

In 2009, the dry matter content of the fruits from the variants cultivated on the basic fertilisation Lumbrical is higher, compared to the other background. The maximum value of the dry matter content in pepper fruits was shown by the variant fed with the biofertiliser Seasol on the basic fertilization Lumbrical (Figure 1).

The highest value of the total sugar content in 2009 (i.e. 6.45%) was reported after the optimum concentration of the basic fertilization Boneprot (Figure 1). It was found that the pepper plants cultivated on the basic fertilisation Lumbrical, topped up by liquid biofertiliser Seasol, had a higher content of total sugars in comparison with those after a single application of the biofertiliser Lumbrical in an optimum concentration.

The vitamin C content in pepper fruit in 2009 (i.e. 123.3 mg%) showed a maximum value after a single application of the biofertiliser Lumbrical in its optimum concentration. In comparison with the results of both combined variant, it was found that the value of vitamin C content in fruits was higher after application of biofertiliser Boneprot, which was due to the content of the two biofetilisers (Figure 1).

In the experimental year of 2010 the dry matter content of pepper fruits showed highest values after basic fertilisation with Boneprot in optimum concentration (8.80%). Upon comparison of the effect of the combined variants on both basic fertilisations, higher results were detected upon the application of the biofertiliser Seasol on the basic fertilization Boneprot (Figure 2).

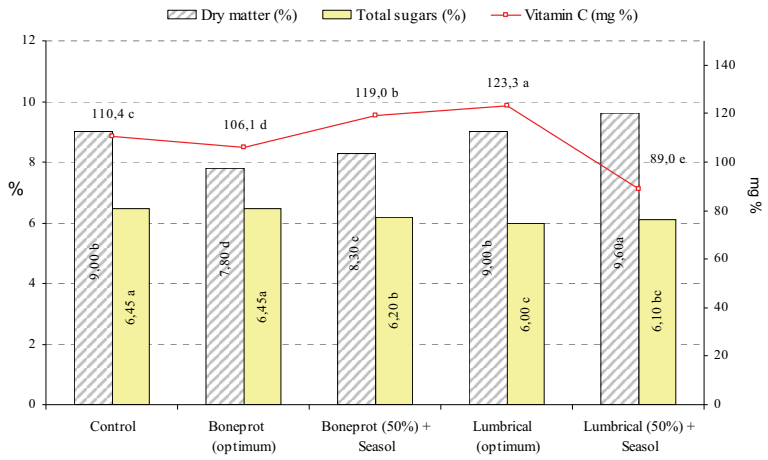

Figure 1. Content of dry matter, total sugars and vitamin C in the pepper fruits-2009

The maximum value of the total sugars content in 2010 was reported for the variant with the applied biofertiliser Seasol on the basic fertilization Lumbrical (8.25%). The results regarding the combined application of a biofertiliser with basic fertilization, in comparison with the detached application of a biofertiliser as basic fertilization, in optimum concentration showed better effect on the total sugar content when a combined fertilizer treatments. The results showed that application of the liquid biofertiliser Seasol on the basic fertilization Lumbrical in 2010 had a maximum value (i.e. 209.4 mg%). The values of vitamin C content in the pepper fruits were reported higher in combined treatments in comparison with control, thus determing the positive effect of the application of the biofertilisers.

The results concerning the dry matter content in pepper fruits in 2011 showed highest values on the basic fertilization Lumbrical (i.e. 8.60 %), thus determine stimulating impact on the biofertilisers (Figure 2). The content of the total sugars in the pepper fruits for the vegetation 2011 year showed that the maximum values by the variant with the biofertiliser Seasol of the basic fertilization Boneprot (i.e. 7.40%). The higher values of the total sugars content was reported in the fruits after the combined application of biofertilisers (i.e. basic fertilization topped up by vegetative feeding), which confirmed the findings in 2010.

Upon application of basic fertilization Boneporot in 2011, highest values of vitamin C content in the pepper fruits (i.e. 181.3 mg%) were shown. There was a better effect on the vitamin C content (i.e. 177.3 mg%) after application of biofertiliser Seasol on the basic fertilization Boneprot, in comparison with the results shown after basic fertilization in optimum concentration.

The results described above are in conjunction with Vlahova and Popov (2013), who showed that the application of the biofertiliser Seasol on both basic fertilisations (i.e. Boneprot and Lumbrical) had a positive effect on the vitamin C content and total sugars, in comparison with single application of basic fertilisations in an optimum concentration in the pepper fruits of variety Kurtovka Kapiya 1619.

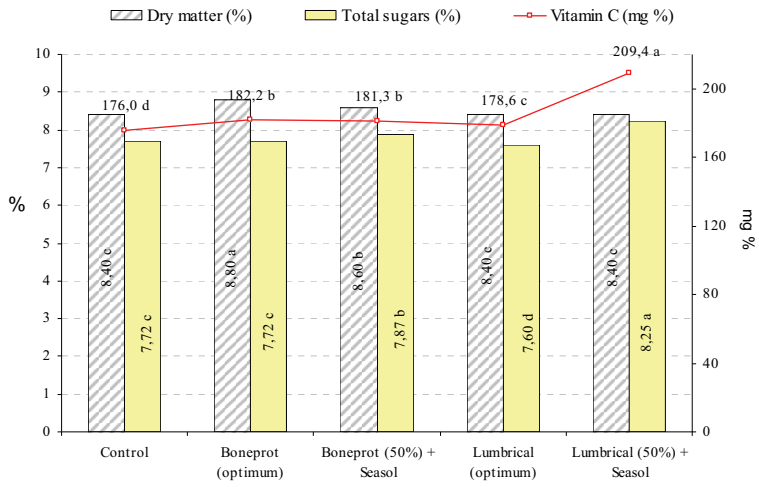

Figure 2. Content of dry matter, total sugars and vitamin C in the pepper fruits-2010

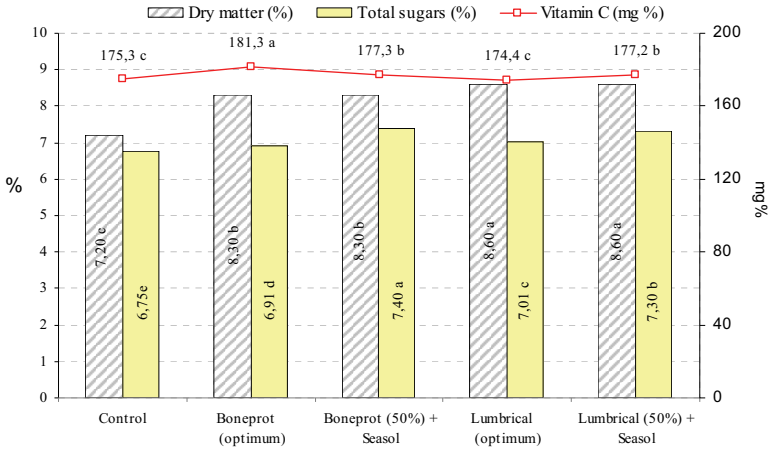

Figure 3. Content of dry matter, total sugars and vitamin C in the pepper fruits – 2011

CONCLUSIONS

It was found that the dry matter content in pepper fruits is highest after application of biofertilisers Seasol on basic fertilisation Lumbrical (2009, 2011) with an average value for the period of 8.87%. The positive impact of the combination of the biofertilisers, i.e. Seasol and Lumbrical, defines the usefulness of the application, which might be applied for other varieties of pepper as well.

It was found that the content of total sugars in pepper fruits during the experimental period varied, as the maximum values were reported for different variants. However, on the average, the higher values of total sugars were shown after the combined application of Seasol on both basic fertilisations in comparison with the single application of the basic fertilisation Lumbrical (i.e. in 2009, 2010, 2011), and on the basic fertilisation Boneprot (i.e. in 2010, 2011). The better combination was the biofertiliser Seasol on the basic fertilisation Lumbrical, which has shown an average of 7.22 % for the period. The positive impact of this combination can be attributed to the nature of these biofertilisers, i.e. enriching the soil with the necessary nutrients and gradually ensuring their release during the growing stages of the pepper. It reflected in better quality of pepper fruits shown by higher content of dry matter and total sugars.

There was no unidirectional tendency towards a maximum value of Vitamin C content shown after application of one type of treatment with biofertilisers. The higher values were reported upon application of the combined variant of Seasol on the basic fertilisation Lumbrical (i.e. in 2010, 2011). The higher attention is paid to Vitamin C content it is perceived as a significant indicator for the quality of pepper fruits.

The results of the study shown by the three indicators for quality of the pepper production are a sufficient evidence for the applicability of biofertilisers in vegetable growing. Besides the improved quality, it is a guarantee for a low risk for the human health.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Project “Vegetative and reproductive parameters of pepper cultivated under the conditions of organic agriculture and possibilities for the application of some types of biofertilisers” No. 03-09 of the Scientific Research Center - Agricultural University - Plovdiv, Bulgaria.

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