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# AGROCHEMICAL EFFICIENCY OF SOIL CONDITIONERS ON THE BASE OF WOOD ASH
## PART 2. AGROCHEMICAL POT-TESTS ON SWEET PEPPER (*CAPSICUM ANNUM* L.*)* VARIETY SOFIISKA KAPIA

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## Abstract

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The investigations on new manure substances and substances which improve the pH and the structure of the soils are very important for improving of the agro-ecological condition of the soils, vegetable yield increasing, economization of raw materials and no to a least point for utilization of some types of wastes like a secondary raw materials in the agriculture. The presented in the current article data are continuation of done investigation over the efficiency of new mixtures for soil conditioners, which are produced on the base of wood ash and additional substances and wastes. Here are generalized the results from done pot-tests, which show the advisability of using of these soil conditioners at cultivation of sweet pepper (*Capsicum annum* L.*)* variety Sofiiska kapia. Based on the results it is proved that in the practice the agrochemical efficiency of the used soil conditioners and the optimal norms of manure are established.

*Key words:* agrochemical effectiveness; soil-conditioners; sweet pepper (*Capsicum annum* L.); wood ash; pot-tests

## Introduction

Decreasing of the chemical fertilizers production in republic of Bulgaria during the past two decades (because of political, financial and other factors), lead to insufficiency of fertilizers for Bulgarian agriculture. From other hand, this insufficiency engendered their import increasing with higher price. At the same time in the country it have many industrial productions which generate or nowadays possess deposited heaps of wastes, which can be utilized like a secondary raw materials in the agriculture. For example such industrial production is the pulp and paper production in 'Svilosa' JSC, the city of Svishtov. In this production for one year are generate 800 t ash from burning of wood wastes, 7 296 t wastes from treating on the calcium oxide and 2 700 t dregs from green lye (Program for Waste Management, 2003).

Still, in republic of Bulgaria, the production of soil conditioners on the basis of different types of wastes, is at the beginning. The direction is perspective, but with attendant difficulties, for example: finding of wastes with appropriate chemical composition (presence of nutrients and absence of harmful and toxic substances); enough quantity of these wastes for industrial production of soil conditioners; opportunity for preparation of suitable mixtures with additional substances and their granulation. The aim of last one is mechanization use of prepared soil conditioners in practical agriculture. This practical use of the soil conditioners must be preceded from proving of their agrochemical efficiency at cultivation of different cultures (Aslantas et al., 2010; Ivanova and Pelovski, 2006; Kuba et al., 2008; Mellouli et al., 1998).

The aim of the current article is to present the experimental data from the done pot-tests for agrochemical efficiency on the obtained new soil conditioners, at cultivation of sweet pepper variety Sofiiska kapia.

## Materials and Methods

***Pot-tests experiments, composition of the used soil conditioners and conditions of the region of cultivation***

The pot-tests are carried out in the period of 01.06 – 15.09.2010, at uninterruptedly control of the moisture and the irrigation norm. The pepper (*Capsicum annum* L.) variety Sofi-

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iska kapia is used on the base of preliminary done literature investigation (Cholakov and Todorov, 2007; Kartalov et all., 1995; Kartalov et al., 1999; Mihov and Alipieva, 1997; Pidov et al., 1995) with the aim of establishing the conformity between the optimal condition of it's growing and the climatic condition of the cultivation region. For the experiments are used three soil conditioners with different composition (from two series: S and M) (Table 1). The obtaining and the properties of the used soil conditioners from series S are detailed in (Mladenov et al., 2011), and for series M – in (Mladenov and Pelovski, 2011).

The experiments are done in village Gara Bov, Svoge municipality, republic of Bulgaria, with geographic coordinates: 43'02'' N, 23''35'' E. The conditions in the region are characterize with clearly defined mountain climate, dominant east wind, altitude ≈ 600 m and slope with south aspect (Climatic Reference Book, 1982; Mladenov et al., 2009; Nikolaeva, 2004).

In the experiments the used soil conditioners are added in two forms – tablet and powder. The experimental plants are planted in pots with capacity of 500 ml. For soil-basis is used the mixture from 9:1 sand and low-productive soil. The used soil and sand are with particles size below 2 mm.

***Used norms of manure and scheme of the experiments***

Four norms are used of manure with this soil conditioners, and each one of them is planted by three pepper plants. Five comparative pot-tests with plants (control) are used without adding of soil conditioners in them. The applied norms of manure are determinate according to the methods presented in sources (Bailey, 1993; Gorbanov et al., 2005; Nikolova, 1995) and they are 50%, 100%, 150% and 200% in relation with the optimal. Detailed scheme of implementation of the pot-tests is presented in Table 2.

During the experiment are observed and measured the following parameters of the pepper plants: total leaf number; stem diameter; stem height and blossoms number.

## Results

The primary data measured at the planting of the plant are accepted for "zero". The obtained data from the weekly measuring the parameters of the experimental plants (the taxonometric data) are compared with these primary data, and the reached data is generalized as value of growth (respectively: number augmentation) at each one measuring. That procedure is detailed in (Mladenov and Pelovski, 2012).

Registration of the experimental values is done by means of direct observations and measurements in fixed period of days. The calculated data are presented in Tables 3-8 and Figures 1-6.

**Table 2**
**Type and form of the used soil conditioner, code of the pot-test and norm of manure**

| Code | Type of the soil conditioner | Form of the soil conditioner | Used norm of manure, $g.kg^{-1}$ dry soil |
|---|---|---|---|
| B00000 | There is not | | 0 |
| BS8T0,5 | **S-8** | Granules | 2.5 |
| BS8T1,0 | **S-8** | Granules | 5.0 |
| BS8T1,5 | **S-8** | Granules | 7.5 |
| BS8T2,0 | **S-8** | Granules | 10.0 |
| BS8P0,5 | **S-8** | Powder | 2.5 |
| BS8P1,0 | **S-8** | Powder | 5.0 |
| BS8P1,5 | **S-8** | Powder | 7.5 |
| BS8P2,0 | **S-8** | Powder | 10.0 |
| BS5T0,5 | S-5 | Granules | 2.5 |
| BS5T1,0 | S-5 | Granules | 5.0 |
| BS5T1,5 | S-5 | Granules | 7.5 |
| BS5T2,0 | S-5 | Granules | 10.0 |
| BS5P0,5 | S-5 | Powder | 2.5 |
| BS5P1,0 | S-5 | Powder | 5.0 |
| BS5P1,5 | S-5 | Powder | 7.5 |
| BS5P2,0 | S-5 | Powder | 10.0 |
| BM5T0,5 | **M-5** | Granules | 2.5 |
| BM5T1,0 | **M-5** | Granules | 5.0 |
| BM5T1,5 | **M-5** | Granules | 7.5 |
| BM5T2,0 | **M-5** | Granules | 10.0 |
| BM5P0,5 | **M-5** | Powder | 2.5 |
| BM5P1,0 | **M-5** | Powder | 5 |
| BM5P1,5 | **M-5** | Powder | 7.5 |
| BM5P2,0 | **M-5** | Powder | 10.0 |

**Table 1**
**Contents of the initial components in the used soil conditioners**

| Soil conditioner type | Content of the component | | | |
|---|---|---|---|---|
| | Wood ash, % | Green lye, % | Ammonium sulphate, % | Sulphuric acid, % |
| S-8 | 50 | 25 | 25 | - |
| S-5 | 45 | 35 | 20 | - |
| M-5 | 55 | 30 | - | 15 |

## Discussion

Using of soil conditioner type S-8 the total leaf number for three from the used norms of manure (2.5, 5.0 and 10.0 g.kg$^{-1}$ dry soil) in powder form of the conditioner, the obtained results are better then the comparative control samples (plants). For the stem height all experimental plants with used norms of manure in powder form and only norm of manure 10.0 g.kg$^{-1}$ dry soil for the tablet (granule) form show better values of growth than the control. From all norms of manure for

**Table 3**
**Data for the total leaf number, at using of soil conditioner type S-8**

| Code | Day of measuring | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0.2 | 0.4 | 0.4 | 0.4 | 2.2 | 6.8 | 6.8 | 8.6 | 9.4 | 9 | 9 | 9.6 | 10 | 9 | 9 |
| BS8T0,5 | 0 | 0.7 | 0.3 | 0 | 1.7 | 6.3 | 6.3 | 6.3 | 6.7 | 6.7 | 7.3 | 7.7 | 7.7 | 7.7 | 7.7 |
| BS8T1,0 | 0 | 0.3 | 0.3 | 0.3 | 1.3 | 7.7 | 8 | 8.7 | 7.7 | 8 | 8.7 | 8.3 | 8.3 | 8 | 7.3 |
| BS8T1,5 | 0 | 0 | 0 | 0 | 2 | 6.7 | 7.7 | 8 | 7.7 | 6.7 | 7 | 8.7 | 8.7 | 7.7 | 10 |
| BS8T2,0 | 0.3 | 0.7 | 0.3 | 0 | 2 | 6.3 | 8 | 8 | 8.3 | 7.7 | 8 | 7.7 | 8 | 7.3 | 9.5 |
| BS8P0,5 | 0 | 0.3 | 0.3 | 1 | 2.3 | 8.3 | 9.3 | 10.3 | 10 | 10 | 10.7 | 10 | 9.3 | 9.3 | 9.3 |
| BS8P1,0 | 0 | 0.7 | 1.3 | 1 | 3 | 8.7 | 10.3 | 10.3 | 10.7 | 10 | 11 | 10.3 | 10 | 10 | 9.7 |
| BS8P1,5 | 0 | 0 | 0.3 | 0.3 | 2 | 5.7 | 7 | 7.3 | 7.7 | 7.3 | 7 | 6.7 | 7.3 | 8 | 7.3 |
| BS8P2,0 | 0.3 | 0.3 | 1.3 | 0.7 | 3 | 8 | 10.7 | 10.3 | 12.7 | 12.3 | 12.7 | 11 | 10.7 | 11.7 | 10.3 |

**Table 4**
**Data for the blossoms number, at using of soil conditioner type S-8**

| Code | Day of measuring | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0 | 0.2 | 0.2 | 1 | 1.2 | 1.4 | 2 | 2.2 | 2 |
| BS8T0,5 | 0 | 0 | 0 | 0 | 0.3 | 1 | 1.3 | 1 | 1.3 |
| BS8T1,0 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 1 | 1 | 1 | 1 |
| BS8T1,5 | 0 | 0.7 | 0.3 | 0 | 0.3 | 1.7 | 1.7 | 2 | 1.7 |
| BS8T2,0 | 0.7 | 0.7 | 0.7 | 0 | 0.3 | 0.3 | 0.3 | 1 | 1.3 |
| BS8P0,5 | 0.3 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 1 |
| BS8P1,0 | 0 | 0.7 | 0.7 | 0.7 | 1.7 | 2.3 | 2 | 2 | 1.7 |
| BS8P1,5 | 0 | 0.3 | 0.7 | 1 | 1 | 0.3 | 1 | 1 | 2 |
| BS8P2,0 | 1.3 | 1.7 | 2.3 | 2 | 1.3 | 1 | 1 | 1 | 1 |

**Table 5**
**Data for the total leaf number, at using of soil conditioner type S-5**

| Code | Day of measuring | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0.2 | 0.4 | 0.4 | 0.4 | 2.2 | 6.8 | 6.8 | 8.6 | 9.4 | 9 | 9 | 9.6 | 10 | 9 | 9 |
| BS5T0,5 | 0 | 0 | 0 | 0 | 1.3 | 4.7 | 6.3 | 7 | 6.7 | 6.3 | 7.3 | 7.7 | 7.7 | 7.3 | 7.3 |
| BS5T1,0 | 0 | 0.3 | 0 | 0 | 0.7 | 6.7 | 7 | 7.7 | 8 | 8 | 8.7 | 9.7 | 10 | 9.3 | 9 |
| BS5T1,5 | 0 | 0 | 0 | 0.3 | 1.3 | 5.3 | 6 | 6 | 7 | 6.7 | 6 | 6 | 6 | 8 | 8.5 |
| BS5T2,0 | 0 | 0.7 | 0 | 1 | 1.3 | 6 | 7 | 7 | 7.3 | 7.7 | 8 | 8.3 | 7.7 | 7.7 | 7 |
| BS5P0,5 | 0 | 0.7 | 0.7 | 1.3 | 2.3 | 6.7 | 7 | 6.7 | 8 | 7 | 7.3 | 6.3 | 6.7 | 8.5 | 9 |
| BS5P1,0 | 0 | 0 | 0.3 | 0.3 | 1 | 5 | 6.3 | 7.3 | 7.3 | 7.3 | 7.7 | 7.3 | 7.3 | 8.7 | 7 |
| BS5P1,5 | 0 | 0.3 | 0 | 0.3 | 1 | 5.3 | 5.7 | 6.3 | 6.3 | 6.7 | 7.7 | 8 | 8 | 7.7 | 9 |
| BS5P2,0 | 0 | 1 | 0 | 0.7 | 2 | 6.3 | 7.3 | 7.3 | 7 | 8 | 8.3 | 9.7 | 9.7 | 10 | 9.3 |

both powder and tablet forms, only at norm of manure 2.5 $g.kg^{-1}$ in tablet form the stem diameter is lower than the control. The earliest blossoming (to a 49 day after the planted) is registered at norms of manure 5.0 and 10.0 $g.kg^{-1}$ for tablet form and 2.5 and 10.0 $g.kg^{-1}$ – for the powder as the last norm was registered the largest value for blossoms number (average 1.3 number/1 plant). The latest blossoming is registered at norm of manure 2.5 $g.kg^{-1}$ in tablet form – to a 77 day after the planted. The higher agrochemical efficiency of the powder form of this type of soil conditioner can be explained with

**Table 6**
**Data for blossoms number, at using of soil conditioner type S-5**

| Code | Day of measuring | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0 | 0.2 | 0.2 | 1 | 1.2 | 1.4 | 2 | 2.2 | 2 |
| BS5T0,5 | 0 | 0 | 0.3 | 0.3 | 0.3 | 0.7 | 1 | 1.3 | 1.7 |
| BS5T1,0 | 0 | 0 | 0 | 0 | 0.3 | 0.7 | 0.7 | 1.3 | 1.3 |
| BS5T1,5 | 0 | 0 | 0 | 0 | 0.3 | 1 | 1 | 2 | 2.7 |
| BS5T2,0 | 0 | 0 | 0 | 0 | 0.3 | 1 | 1.7 | 2 | 2.3 |
| BS5P0,5 | 0.3 | 0.3 | 0.3 | 0.3 | 1 | 1 | 1.3 | 1.7 | 1.3 |
| BS5P1,0 | 0 | 0 | 0.3 | 0.3 | 0.3 | 1 | 0.7 | 0.7 | 1.7 |
| BS5P1,5 | 0 | 0 | 0 | 0.3 | 0 | 0.3 | 2 | 2 | 2.7 |
| BS5P2,0 | 0 | 0 | 0 | 0 | 0.3 | 0.7 | 2 | 2.3 | 2.7 |

**Table 7**
**Data for the total leaf number, at using of soil conditioner type M-5**

| Code | Day of measuring | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0.2 | 0.4 | 0.4 | 0.4 | 2.2 | 6.8 | 6.8 | 8.6 | 9.4 | 9 | 9 | 9.6 | 10 | 9 | 9 |
| BM5T0,5 | 0 | 1 | 0.7 | 0 | 1.3 | 7.7 | 8.3 | 9 | 9 | 8.7 | 10.7 | 11.7 | 11.3 | 11.3 | 11 |
| BM5T1,0 | 0 | 0 | 0.7 | 0.3 | 1.7 | 6.7 | 7.3 | 7.3 | 8 | 8 | 7.7 | 8 | 9 | 8 | 9.5 |
| BM5T1,5 | 0.3 | 0.3 | 0.3 | 0 | 0.7 | 6.7 | 6.7 | 7 | 7.7 | 8 | 9.3 | 9 | 9 | 9.3 | 9.3 |
| BM5T2,0 | 0 | 0 | 0.3 | 0 | 0.7 | 6.3 | 6.7 | 7.3 | 8 | 8.3 | 7.7 | 8.7 | 8.3 | 8 | 8 |
| BM5P0,5 | 0 | 0 | 0.3 | 0.3 | 0.7 | 5.7 | 6.7 | 7.7 | 7.3 | 7.3 | 8.7 | 8.7 | 8.3 | 8 | 8 |
| BM5P1,0 | 0.7 | 1 | 0.7 | 0.7 | 1.3 | 6.3 | 8.7 | 9.3 | 8.7 | 8.7 | 9.7 | 8.3 | 8.7 | 9 | 9 |
| BM5P1,5 | 0 | 1 | 0.7 | 0.3 | 1.7 | 7.3 | 8.3 | 8.7 | 8.7 | 8.7 | 9.7 | 9 | 9 | 9 | 8.3 |
| BM5P2,0 | 0 | 0.3 | 0.7 | 0 | 1.3 | 6.3 | 7 | 8.7 | 9 | 8 | 8.3 | 7.7 | 8.7 | 8.7 | 9 |

**Table 8**
**Data for the blossoms number, at using of soil conditioner type M-5**

| Code | Day of measuring | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 49 | 56 | 63 | 70 | 77 | 84 | 91 | 98 | 105 |
| B00000 | 0 | 0.2 | 0.2 | 1 | 1.2 | 1.4 | 2 | 2.2 | 2 |
| BM5T0,5 | 0 | 0 | 0 | 0.3 | 1 | 1 | 2 | 2 | 2 |
| BM5T1,0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 2 | 2.3 | 2.3 |
| BM5T1,5 | 0 | 0 | 0 | 0 | 0 | 0.3 | 2 | 1.7 | 4 |
| BM5T2,0 | 0 | 0 | 0.3 | 0.3 | 0.3 | 0.3 | 2.3 | 2 | 3 |
| BM5P0,5 | 0 | 0 | 0 | 0 | 0 | 0.7 | 1.3 | 1.3 | 1.3 |
| BM5P1,0 | 0 | 0 | 0 | 0 | 0 | 0.7 | 2 | 3 | 3.3 |
| BM5P1,5 | 0 | 0 | 0 | 0 | 0.3 | 0.3 | 0.3 | 1.3 | 1.3 |
| BM5P2,0 | 0 | 0 | 0 | 0 | 0 | 0.3 | 1.7 | 2 | 3 |

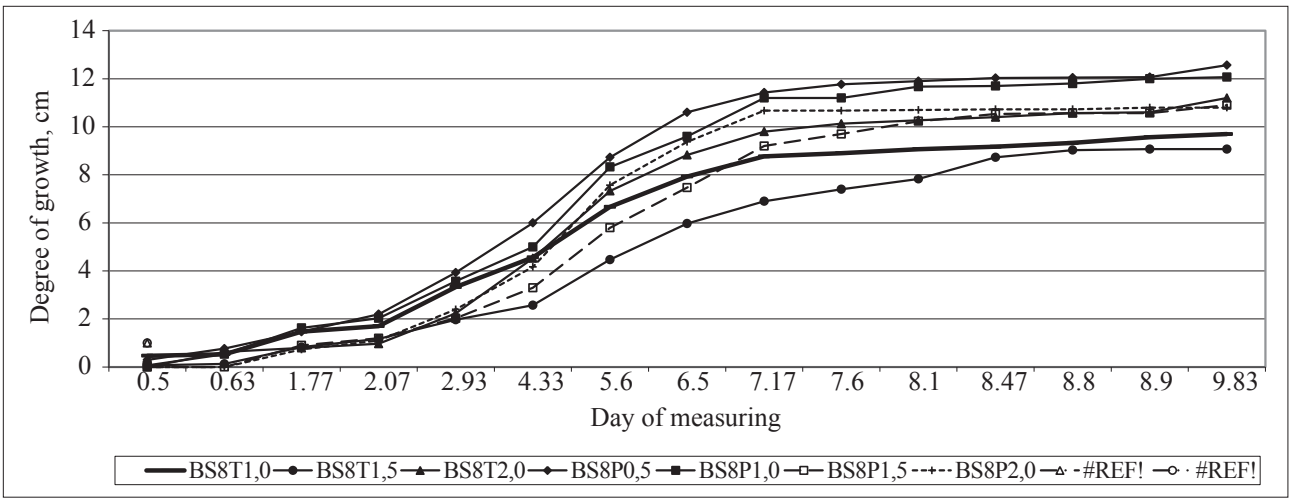


**Fig. 1. Alteration of the stem height of the plants, at using of soil conditioner type S-8**

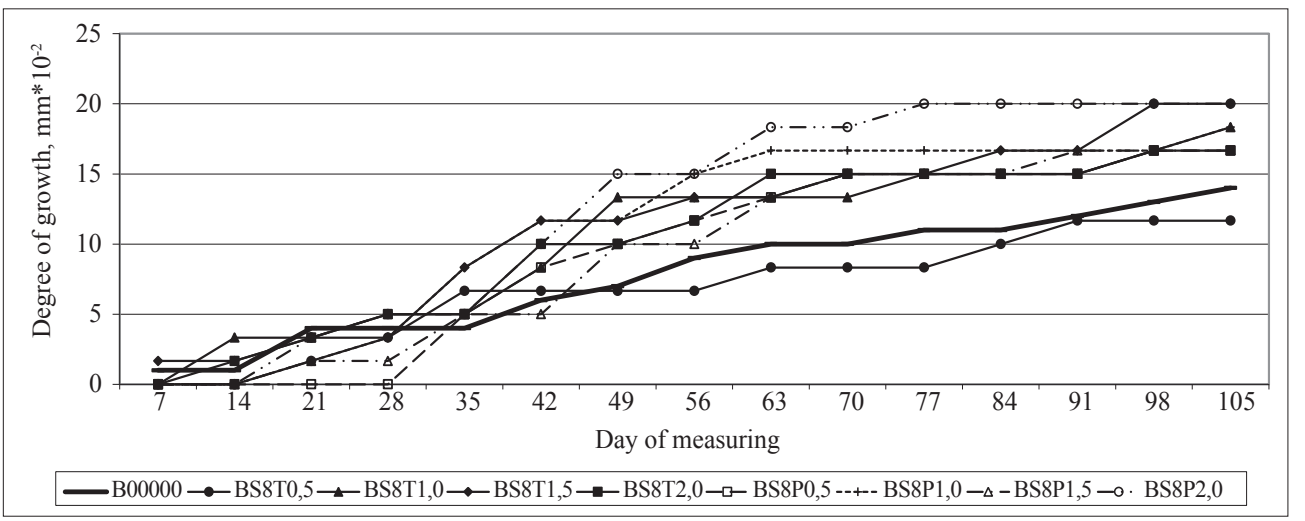


**Fig. 2. Alteration of the stem diameter of the plants, at using of soil conditioner type S-8**

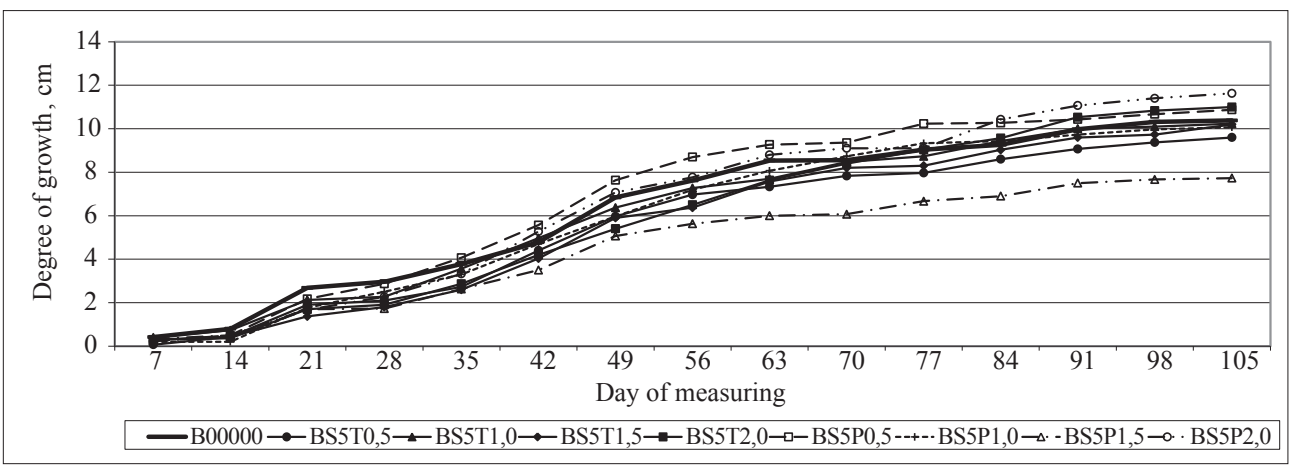


**Fig. 3. Alteration of the stem height of the plants, at using of soil conditioner type S-5**

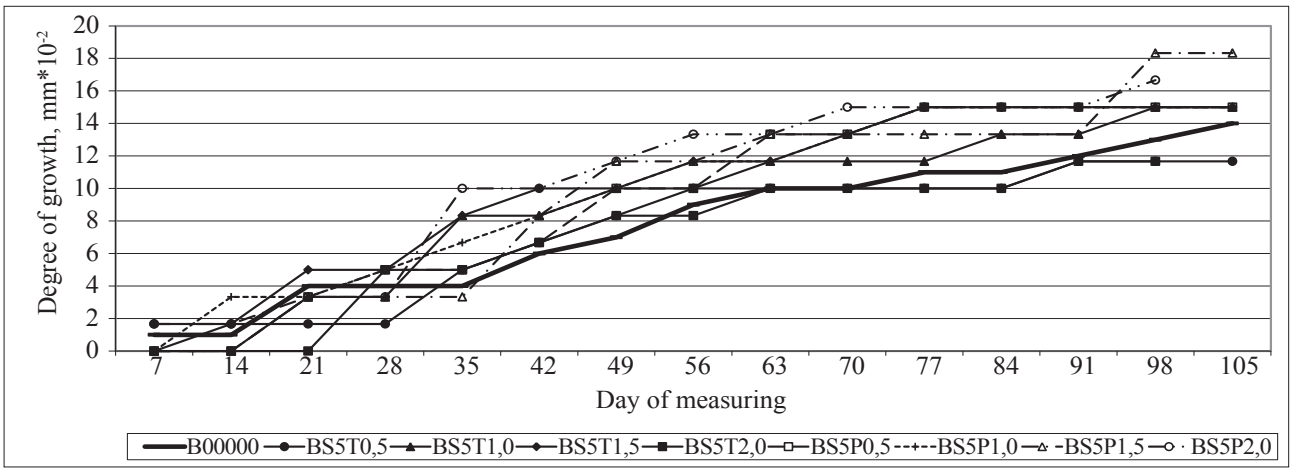


**Fig. 4. Alteration of the stem diameter of the plants, at using of soil conditioner type S-5**

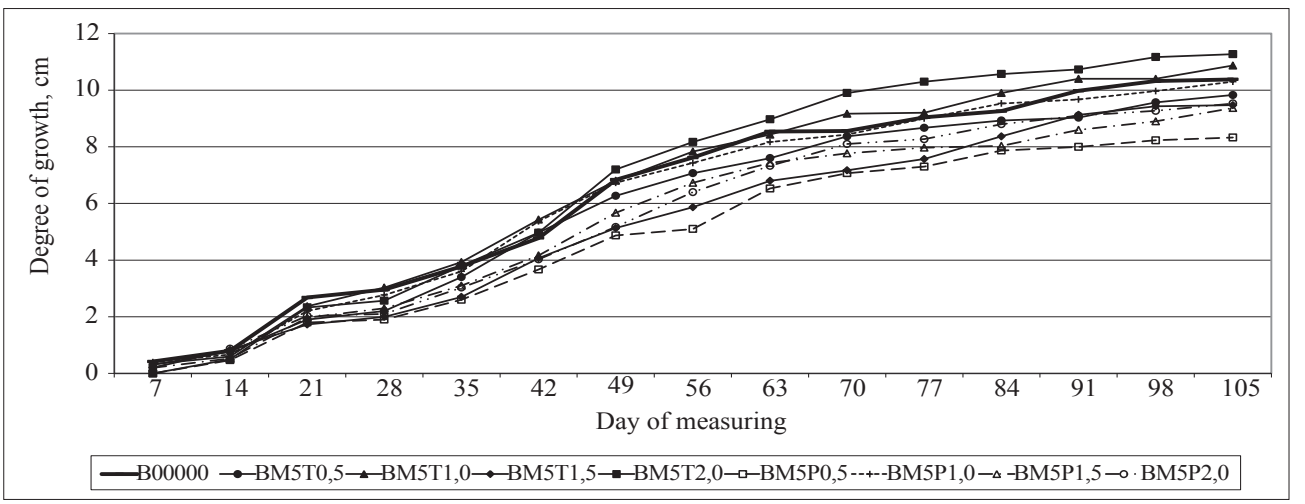


**Fig. 5. Alteration of the stem height of the plants, at using of soil conditioner type M-5**

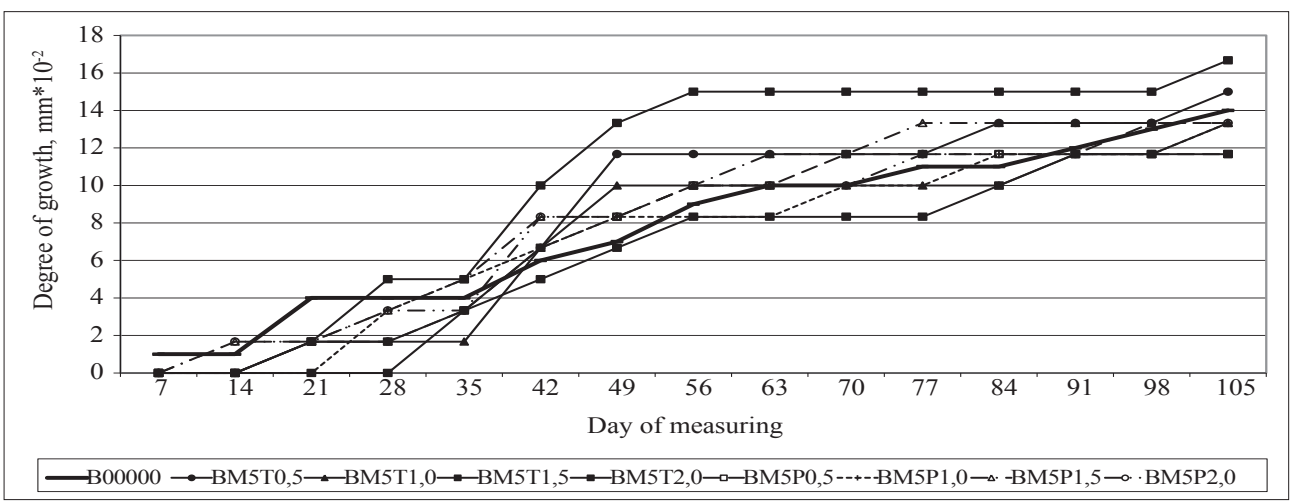


**Fig. 6. Alteration of the stem diameter of the plants, at using of soil conditioner type M-5**

the quick speed of transformation of the nutrients in soil layer and their more completed and earlier assimilation from the plants.

For soil conditioner type S-5, when the green lye content is higher and ammonium sulphate content is lower than the S-8, for parameter total leaf number at the plants with used norms of manure does not registered increment than the control samples (exception is norm of manure 2.5 $g.kg^{-1}$ in tablet form during the past two weeks of the vegetation period). Higher degree of growth than the control of the stem high are registered at norms of manure in powder form – 2.5 $g.kg^{-1}$ and 10.0 $g.kg^{-1}$, and in tablet form – 10.0 $g.kg^{-1}$. All used norms of manure in the powder form of this soil conditioners and norms of manure 5.0 and 7.5 $g.kg^{-1}$ in tablet form, show better degree of growth of the stem diameter than the control. The earliest blossoming is observed at norm of manure 2.5 $g.kg^{-1}$ in powder form – to a 49 day after the planted. At comparing on the agrochemical efficiency of the both forms for this type of soil conditioner, obtained results show that it is higher for the powder form.

The values for parameter total leaf number for soil conditioner M-5 are higher at norm of manure: 2.5 $g.kg^{-1}$ for tablet form. At parameter stem height like the most effectiveness show up the norms of manure 5.0 and 10.0 $g.kg^{-1}$ in tablet form and 5.0 $g.kg^{-1}$ in powder. On basis of the obtained results for stem diameter of the plants can not be choose the most effectiveness norm of manure – here five from used norms (three in powder and two in tablet form) show stable higher degree of growth than the control. The earliest blossoming is observed at norm of manure 10.0 $g.kg^{-1}$ in tablet form – to a 63 day. As previous our studies with pepper variety Sivria ST (Mladenov and Pelovski, 2012) and here was observed lower agrochemical efficiency of this type of soil conditioner mostly fall on of ammonium sulphate absence, which is main source of nitrogen and sulphur like as nutrients in ionic form for the soil solution.

From done pot-tests with the three types of soil conditioners and pepper variety Sofiiska kapia determined that it has optimal norms of manure in which norms they advantage growth of the stem diameter and stem high of the plants and their earlier blossoming, expressed clearly at soil conditioner type S-8. Here for pepper variety Sofiiska kapia also like the variety Sivria ST (Mladenov and Pelovski, 2012) was established that the used soil conditioners from series S advantage the earlier blossoming than the series M.

The results for pepper variety Sofiiska kapia confirm the results for pepper variety Sivria ST (Mladenov and Pelovski, 2012) and that the soil conditioner type S-8 have higher agrochemical efficiency. For the first one variety, the powder form use from this soil conditioner is preferable.

## Conclusion

On basis of the done comparative analysis of the obtained data from the pot-tests can be concluded that the most effective for growth of the pepper variety Sofiiska kapia is soil conditioner type S-8 at norms of manure 2.5 and 5.0 $g.kg^{-1}$ – for the powder form, and 10.0 $g.kg^{-1}$ – for the tablet form. The results obviously are in connection with the high content of ammonium sulphate in this type of soil conditioner, which is the main source of nitrogen and sulphur respectively in ammonium and sulphate forms in soil solution. For variety Sofiiska kapia the powder form use of this type of soil conditioner is preferable.

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