Bulgarian Journal of Agricultural Science, 18 (No 3) 2012, 354-361
Agricultural Academy

AGROCHEMICAL EFFICIENCY OF SOIL CONDITIONERS ON THE BASE OF WOOD ASH

Part 1. Agrochemical Pot-Tests on Sweet Pepper (*Capsicum annum* L.) Variety „Sivria ST"

M. K. MLADENOV and Y. G. PELOVSKI
University of Chemical Technology and Metallurgy, Center of Ecology, BG - 1756 Sofia, Bulgaria

Abstract

MLADENOV, M. K. and Y. G. PELOVSKI, 2012. Agrochemical efficiency of soil conditioners on the base of wood ash. Part 1. Agrochemical pot-tests on sweet pepper (*Capsicum annum* L.*)* variety „Sivria ST". *Bulg. J. Agric. Sci.,* 18: 354-361

The utilization of ashes from burning of different vegetal wastes in the agriculture, allow the structure improvement of the soils and the nutrient balance to improve, as well as the regulation to pH of the soil solution. Some examinations show that the ashes can also improve the sorption properties and the water balance of the soils. There is data in the literature for the positive agrochemical efficiency, that comes from using the different composite mixtures on the base of the vegetal wastes, after different methods of treatment. Most frequently they use the methods of composting, but in the last years physicochemical methods of treatment and production of soil conditioners are develop are also used. In the current article we present a new data from realized investigation over efficiency on soil conditioners, obtained on the base of wood ash and green lye from cellulose production, through mixing with ammonium sulphate and sulphuric acid. The pot-tests for cultivation of sweet pepper (*Capsicum annum* L.) variety „Sivria ST" are done with two forms of the obtained conditioners – in tablet form and in powder form. 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; pot-tests; soil conditioners; sweet pepper (*Capsicum annum* L.); wood ash

Introduction

In correspondence with the global necessity for minimization of the generated wastes, there are more results in literature are produce more results from investigations on the production and the application of new and more effective soil conditioners which are obtained on the base of different wastes. One for the use of that types of conditioners is achieving of higher yields and decreasing of the quantities of the used chemical fertilizers (Arancon et al., 2004; Arancon et al., 2005; Dimcheva et al., 2008; Ivanova and Pelovski, 2006; Kim et al., 1997; Nikolov and Shaban, 2011; Petkova and Poryazov, 2007; Sapundjieva et al., 2009; Tringovska et al., 2008; Tringovska and Kanazirska, 2008; Vasileva et al., 2007; Zdravkov et al., 2005). The vegetable cultures are one from the very often used vegetable species in pot-tests for demonstration of the agrochemical efficiency, by two reasons: brief life cycle; possibility for cultivation in all region of the Bulgarian republic territory.

The sweet pepper is one of the basic agricultural cultures which is cultivate in the republic of Bulgaria. It gains the second place of economic importance among the vegetable products in the country (Cholakov and Todorov, 2007; Nikolova and Jordanova, 2000). The most optimal conditions for its growing are: the warm weather with a little twenty-four-hour tempera-

E-mail: mladenov@uctm.edu

ture fluctuations – in an interval 18 – 30°C (Kartalov et al., 1999; Mihov and Alipieva, 1997). This culture is characterized with high sensitiveness to the sunlight – it doesn`t stand the overshadow (Kartalov et al., 1999). The pepper is reacting very fast on the type of feeding with organic and mineral fertilizers and definitely it is sensitive by the calcium content in the soil system. It is resisting only to pH of the soil solution up to 5.5 (Genkova, 2008; Mihov and Alipieva, 1997).

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 "Sivria ST".

Materials and Methods

Pot-tests experiments and composition of the used soil conditioners

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 "Sivria ST" is used on the base of preliminary done literature investigation (Cholakov and Todorov, 2007; Kartalov et al., 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 (Mladenov et al., 2011) and for series M (Mladenov and Pelovski, 2011).

In the experiments the used soil conditioners are added in two forms – in tablet form (like granules) and in powder form. 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.

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

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. Also five comparative pot-tests with plants 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.

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
A00000	There is not		*0*
AS8T0,5	S-8	Granules	2.5
AS8T1,0	S-8	Granules	5.0
AS8T1,5	S-8	Granules	7.5
AS8T2,0	S-8	Granules	10.0
AS8P0,5	S-8	Powder	2.5
AS8P1,0	S-8	Powder	5.0
AS8P1,5	S-8	Powder	7.5
AS8P2,0	S-8	Powder	10.0
AS5T0,5	S-5	Granules	2.5
AS5T1,0	S-5	Granules	5.0
AS5T1,5	S-5	Granules	7.5
AS5T2,0	S-5	Granules	10.0
AS5P0,5	S-5	Powder	2.5
AS5P1,0	S-5	Powder	5.0
AS5P1,5	S-5	Powder	7.5
AS5P2,0	S-5	Powder	10.0
AM5T0,5	M-5	Granules	2.5
AM5T1,0	M-5	Granules	5.0
AM5T1,5	M-5	Granules	7.5
AM5T2,0	M-5	Granules	10.0
AM5P0,5	M-5	Powder	2.5
AM5P1,0	M-5	Powder	5
AM5P1,5	M-5	Powder	7.5
AM5P2,0	M-5	Powder	10.0

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 is done on base of next formula:

$M_x = A - A_0$

where: M_x – average growth at date „x" for the respective type of soil conditioner and norm of manure;

A – average value for the respective parameter measured at the weekly measuring;

A_0 – average "zero" value for the respective parameter measured at the planting of the plant.

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 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
A00000	0	0.7	0.4	0.2	1.2	6.4	7	8.4	8.6	8.4	8.8	8.8	8.8	8.1	8.4
AS8T0,5	0	0	0.3	0.3	1.7	7	9.3	9.3	9.7	10.3	10	10	10.7	9.3	9.3
AS8T1,0	0	0.3	0.7	0.7	1.7	6.7	7.7	8	8.7	7.7	8	8.7	8	8	8.3
AS8T1,5	0	0	0	0.3	2.3	7	7	8.3	9	9	9	9.3	10.3	10	11
AS8T2,0	0	0	0.3	1	2.7	5.7	8	8.7	8.7	8.7	8.7	8.3	8.3	8.7	9
AS8P0,5	0	0.7	0.7	0.7	1.7	6.3	5.7	7	7.7	7.3	8	9	9	9.3	8.7
AS8P1,0	0	0	0.7	0.3	1	7.7	9	10.7	10.3	9.7	9.7	10.7	12	9.7	10
AS8P1,5	0	0	0.5	0	2	6.5	7.5	8	9.5	10	11	9.5	10.5	9	9
AS8P2,0	0	0	0.3	0	3	8	9.7	9	10.3	10.7	10.3	9.3	11	10	10.7

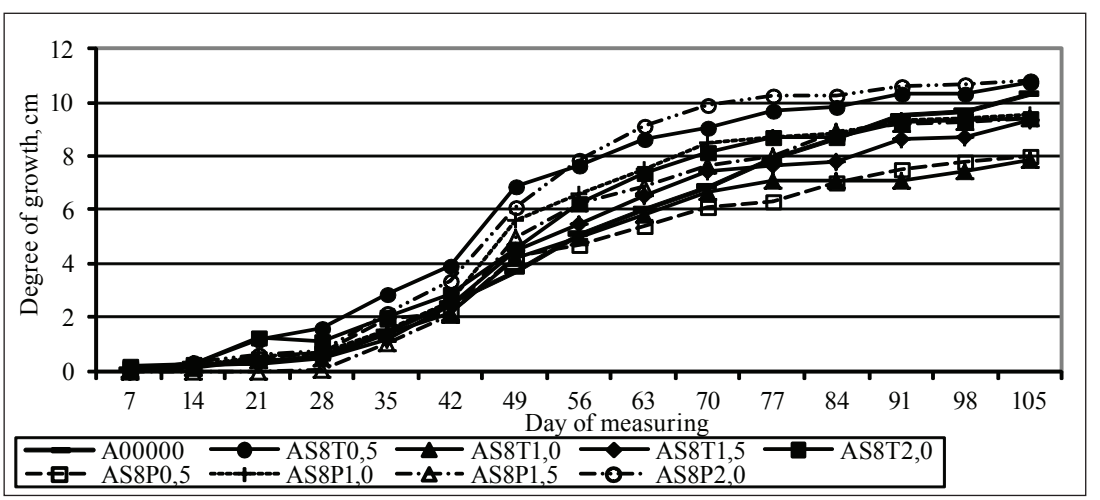

Fig. 1. Alteration of the stem height of the plants, at using of soil conditioner type S-8

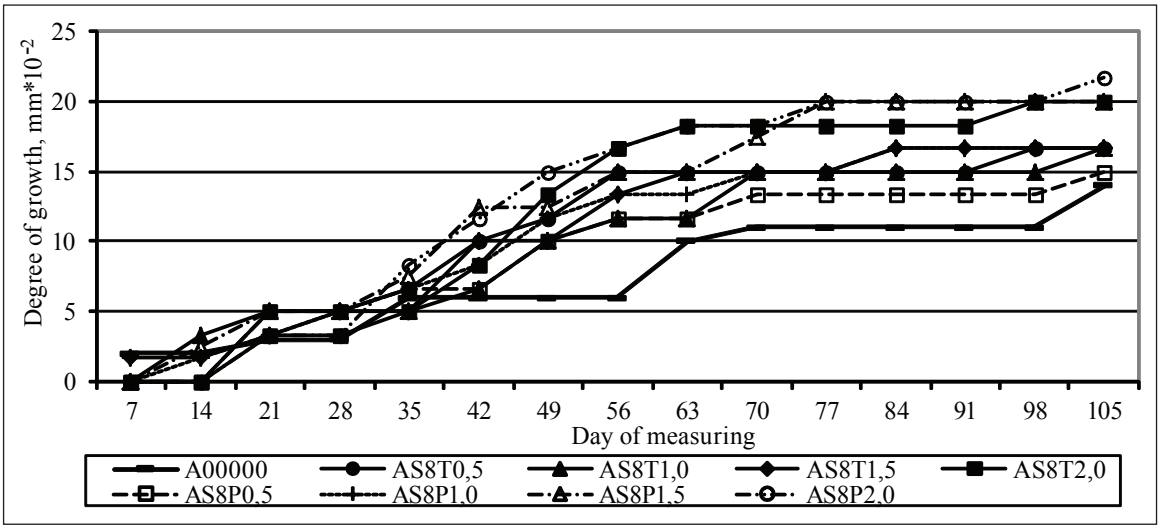

Fig. 2. Alteration of the stem diameter of the plants, at using of soil conditioner type S-8

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
A00000	0	0	0	0	1.2	1.6	1.8	2.3	2
AS8T0,5	0	0	0	0	0.3	0	0.3	0.7	1.3
AS8T1,0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.7
AS8T1,5	0.3	0.3	0.3	0.3	0	0	0.7	1	1.3
AS8T2,0	0	0.7	0.7	0.7	0.7	0.3	0.3	0.3	1.3
AS8P0,5	0	0	0	0	0	0	0	0	0
AS8P1,0	0.3	0	0.3	0.3	0.3	0.7	0.3	0.3	0.3
AS8P1,5	0	1	1	1	1	1	1	1	1
AS8P2,0	0.3	0.7	0.7	0.7	0.3	1.3	0.7	1	0.3

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
A00000	0	0.7	0.4	0.2	1.2	6.4	7	8.4	8.6	8.4	8.8	8.8	8.8	8.1	8.4
AS5T0,5	0	0.3	0.7	0.3	1.3	6.3	7.7	8	8	8.7	8.3	9	9	9	10
AS5T1,0	0	0.3	0.7	0.7	2.3	6.7	6.7	7	7.3	7.7	8.3	9.3	9.3	9	9.7
AS5T1,5	0	0	0.7	0.3	0.7	5.7	6	6.3	6.7	7	8	7.7	7.7	8.3	10.3
AS5T2,0	0	0.3	0.7	0.7	1.7	6.3	6.7	7	8	8.7	9	9.3	10	9.7	9
AS5P0,5	0	0.3	1.3	1.3	1.7	6.7	7.3	8	8	7.7	8.7	8.7	8.7	8.3	7.7
AS5P1,0	0	0.3	1	1.3	2.3	6	7.3	7	7.7	8.3	8.3	8	8	7	7.7
AS5P1,5	0	0.3	1.3	1	2.3	7.3	7.3	7.7	8.3	7.7	8	7.7	7	8.3	8.8
AS5P2,0	0	0	0.3	0.3	2.3	6.7	6.7	8.3	8	7	7.3	8	9.3	9	10

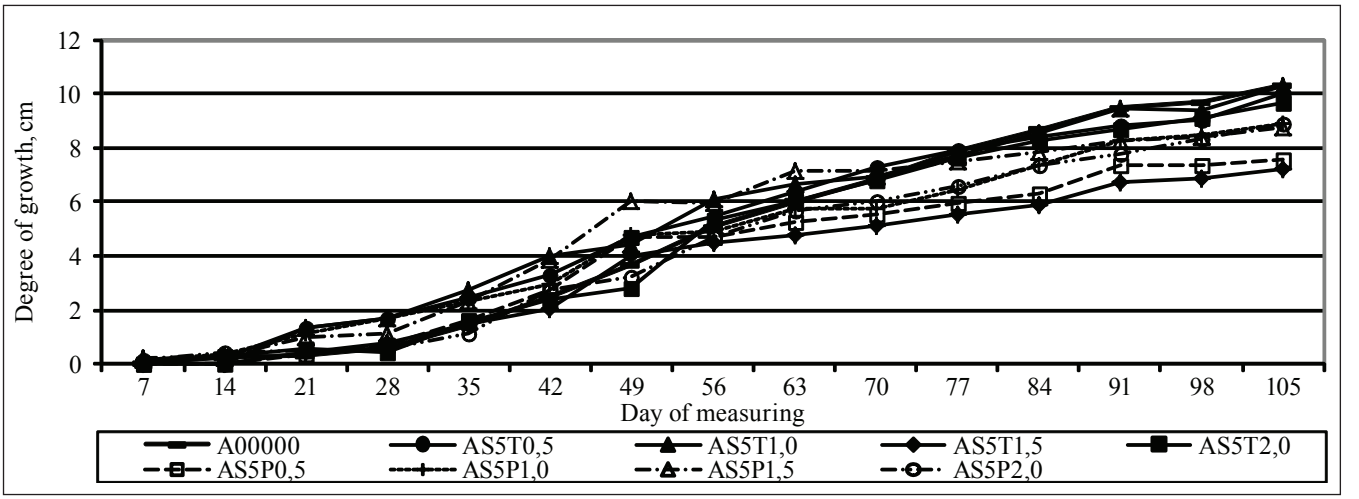

Fig. 3. Alteration of the stem height of the plants, at using of soil conditioner type S-5

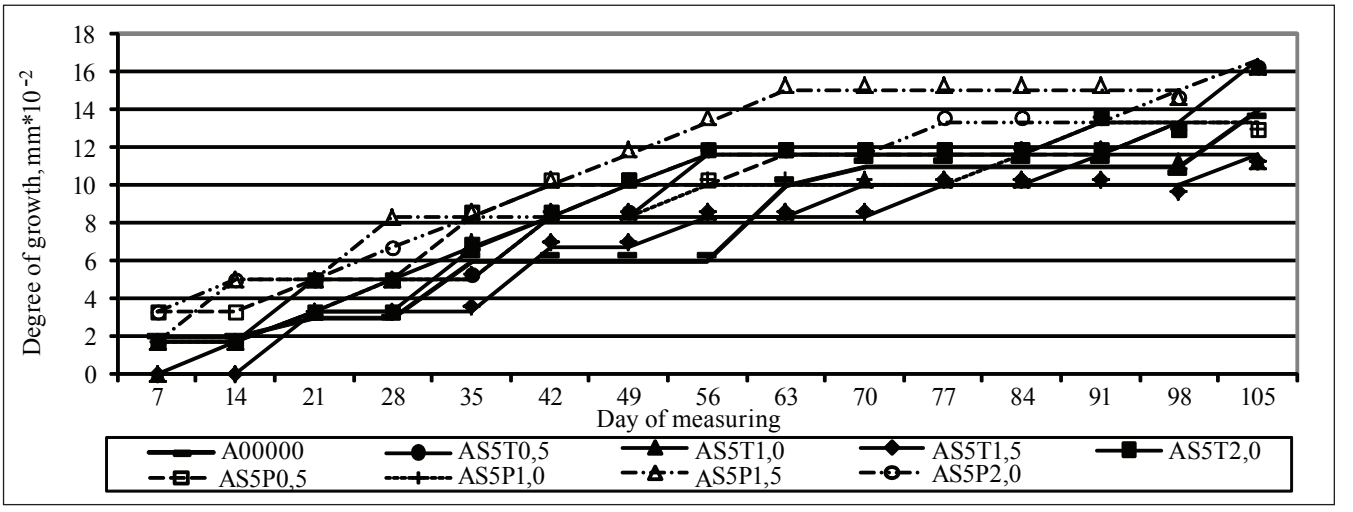

Fig. 4. Alteration of the stem diameter of the plants, at using of soil conditioner type S-5

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
A00000	0	0	0	0	1.2	1.6	1.8	2.3	2
AS5T0,5	0	0	0	0	0	0	1	1.3	1.7
AS5T1,0	0	0	0	0	0	0	0	0.3	0.7
AS5T1,5	0	0.3	0.3	0.3	0.3	0.3	1	1.3	1.7
AS5T2,0	0	0	0	0	0	0	0.7	0.7	0.7
AS5P0,5	0	0	0	0	0	0	0	0.3	1
AS5P1,0	0	0	0	0	0	0	1	1.7	2.3
AS5P1,5	0	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
AS5P2,0	0	0	0	0	0	0	0.7	1	2.3

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
A00000	0	0.7	0.4	0.2	1.2	6.4	7	8.4	8.6	8.4	8.8	8.8	8.8	8.1	8.4
AM5T0,5	0	0	0	1	2	7.3	7.7	7.7	8.7	9	9.3	10	10	9.7	10
AM5T1,0	0	0	0.3	0.7	1	5.3	6.7	6.7	6.3	7	8.3	8	8	7.3	7.7
AM5T1,5	0	0.3	0.3	0.3	0.3	5.3	6	6.7	6.7	7	8.3	9	8.7	8.3	8.5
AM5T2,0	0	0	0	0.7	1	6	6.7	7	6.3	6.7	7.3	7	8.7	8.7	9.7
AM5P0,5	0	0.3	1.3	1.3	2.3	7.3	7.3	9	8.7	9	9.7	10	10	10.3	9.7
AM5P1,0	0	0.3	1	1.7	2.3	7.7	7.3	7.3	7.7	7.3	8.3	10	10	9	9.7
AM5P1,5	0	0	0.7	0.7	2	6.3	7.3	8.3	9.3	9.3	10.7	11	10.3	10.7	11.7
AM5P2,0	0	0	0.7	0.7	1.3	6	6.7	6.3	7	8	8.7	9	9.3	9.7	10.3

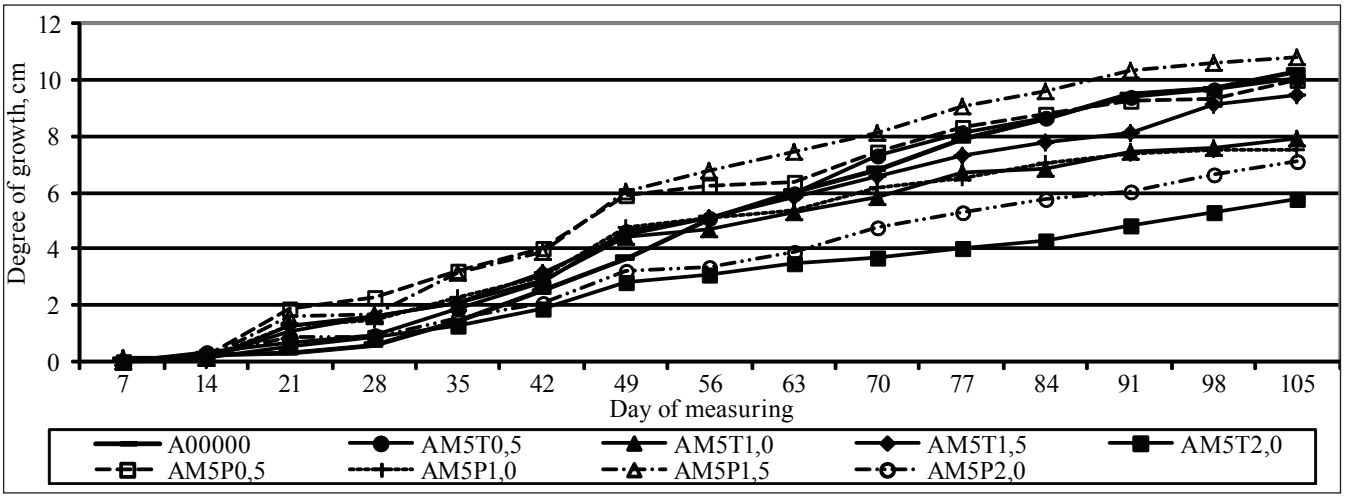

Fig. 5. Alteration of the stem height of the plants, at using of soil conditioner type M-5

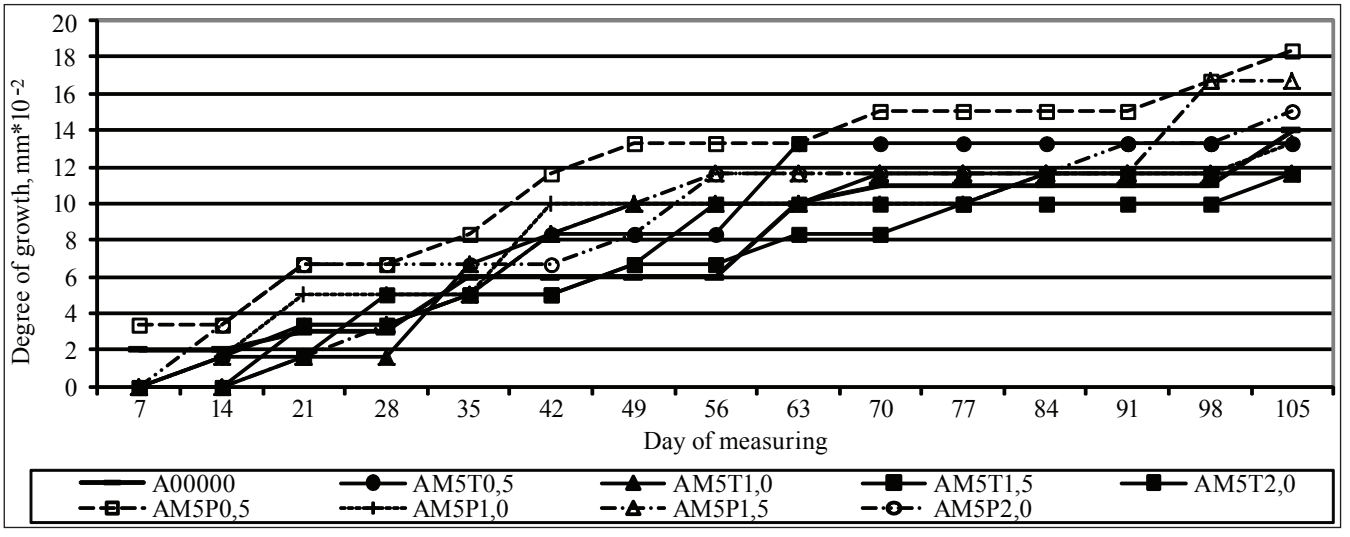

Fig. 6. Alteration of the stem diameter of the plants, at using of soil conditioner type M-5

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
A00000	0	0	0	0	1.2	1.6	1.8	2.3	2
AM5T0,5	0	0	0	0	0	0	0	0.3	1.7
AM5T1,0	0	0	0	0	0	0	0.3	0.7	0.7
AM5T1,5	0	0	0	0	0	0	0	0.3	0.7
AM5T2,0	0	0	0	0	0	0	0.3	0.3	1
AM5P0,5	0	0	0	0	0	0	1.3	1.7	1.7
AM5P1,0	0	0	0	0	0.3	0.3	0.7	0.7	1
AM5P1,5	0	0	0	0	0.3	1	1.3	1.7	1.7
AM5P2,0	0	0	0	0	0	0.7	0.7	0.7	1.7

Discussion

Using of soil conditioner type S-8 the stem high of the plants is bigger for the entire period of vegetation at using of norms of manure from 2.5 $g.kg^{-1}$ dry soil for tablet form and 10 $g.kg^{-1}$ for powder form of the conditioner. In all norms of manure independently from the conditioner form, the stem diameter is bigger than the comparative "zero" sample (plants). The earliest blossoming is registered at norms of manure 5.0 and 7.5 $g.kg^{-1}$ for tablet forms and 7.5-10.0 $g.kg^{-1}$ – for the powder form. For the powder form of this soil conditioner, for optimal norm of manure can be accepted 10.0 $g.kg^{-1}$, when for the entire period of vegetation they have the highest values of the measured parameters (stem high and diameter and total leaf number). The higher agrochemical efficiency of the lower norms of manure for the tablet forms of this soil conditioners can be explained with the slower speed of transformation of the nutrients in soil layer and their more completed assimilation from the plants. It is possible they can have connection with some pH change of the soil solution.

For soil conditioner type S-5, when the ammonium sulphate content is lower and green lye content is higher, stable values are measured for parameters stem high and stem diameter for the initial period of vegetation and for longer period of time they are measured bigger blossoms number at the higher norms of manure – 5.0-10.0 $g.kg^{-1}$ dry soil. The earliest blossoming is observed at norms of manure 7.5 $g.kg^{-1}$ – for the tablet form and 10.0 $g.kg^{-1}$ – for the powder form. The results show that at soil conditioner type S-5 agrochemical efficiency is lower than soil conditioner type S-8, which allows from the second to be use lower norms of manure. In the practice this two types of soil conditioners are preferable is the tablet form.

At soil conditioner type M-5 higher values of the measured parameters are established only in the high norms of manure and in same time at the powder form they are registered more steady positive results. It is obvious that the lower agrochemical efficiency of this type of 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-test with these three types of soil conditioners is determined that it has optimal norms of manure in which norms they advantage growth of the stem diameter and stem high of the plants. The used soil conditioners from series S advantage the earlier blossoming and more powerful leaf mass. The data from the three used soil conditioners shows the growth of the total leaf number of the plants in which are applied norms of manure than the control plants. It is expressed clearly that the soil conditioner type S-8, with norms of manure 5.0 and 7.5 $g.kg^{-1}$ – for the tablet form, and 7.5-10.0 $g.kg^{-1}$ – for the powder form

Conclusion

On base 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 "Sivria

ST" is soil conditioner type S-8 at norms of manure 5.0 and 7.5 $g.kg^{-1}$ – for the tablet form, and 7.5-10.0 $g.kg^{-1}$ – for the powder form. The results for this type of soil conditioner obviously are in connection with the high content of ammonium sulphate in it, which is the main source of nitrogen and sulphur respectively in ammonium and sulphate forms in soil solution, which can be assimilated easy from the plants. The tablet form use from this soil conditioner is preferable, because of the possibility of use of lower norms of manure.

Acknowledgements

The authors would like to thank the Science and Research Program of the University of Chemical Technology and Metallurgy – Sofia (Contracts 10703/01.02.10 and 10828/01.03.11).

References

Arancon, N. Q, Cl. A. Edwards, R. Atiyeh and J. D. Metzger, 2004. Effects of vermicomposts produced from food waste on the growth and yields of greenhouse peppers. *Bioresour. Technol*., **93:** 139–144.

Arancon, N. Q., Cl. A. Edwards, P. Bierman, J. D. Metzger and C. Lucht, 2005. Effects of vermicomposts produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. *Pedobiologia.* **49**: 297-306.

Bailey, J., 1993. Soil and Crop Analysis – A Pocket Manual. Queen's University, Belfast, pp.108.

Cholakov, T. and Y. Todorov, 2007. Phenological development of pepper varieties distributed in Bulgaria. *Plant Science (Rasteniev'dni nauki*), **44**(2): 150-153 (Bg).

Dimcheva, Cv., I. Dimov and Hr. Boteva, 2008. Bioproducts and crop from green pepper. *Agriculture plus,* 7-8: 19-20 (Bg).

Genkova, I., 2008. Pepper – cultivation, illnesses and pests. Eniovche, Sofia – Bulgaria, pp. 20-27 (Bg).

Gorbanov, S., L. Stanchev, I. Matev, T. Tomov and G. Rachovski, 2005. Agrihimiq. *Dionis,* Sofia – Bulgaria, pp. 368-397 (Bg).

Ivanova, V. and Y. Pelovski, 2006. Utilization of mixed fertilizers, containing coal ashes from thermal power plant for improving olive trees productivity. *J. Univ. Chem. Technol. Met.,* (Sofia). **41** (3): 325-328.

Kartalov, P., M. Alipieva, S. Genchev, V. Rankov, M. Petkov, P. Lozanov, B. Velev, L. Ivanov, P. Surlekov, D. Bahariev, M. Doikova, H. Simidchiev, E. Uzunova and A. Stoicev, 1995. Zelenchukoproizvodstvo za vsichki. *ZEMIZDAT*, Sofia – Bulgaria, pp. 210-217 (Bg).

Kartalov, P., M. Doikova and P. Boshnakov, 1999. Zelenchukoproizvodstvo sus semeproizvodstvo. *Videnov and son*, Sofia – Bulgaria, pp. 129-145 (Bg).

Kim, K. D., S. Nemec and G. Musson, 1997. Effects of composts and soil amendments on soil microflora and *Phytophthora* root and crown rot of bell pepper. *Crop Protection,* **16** (2): 165-172.

Mihov, At. and M. Alipieva, 1997. Praktichesko zelenchukoproizvodstvo. *PSSA*, Sofia, pp. 64-74 (Bg).

Mladenov, M. K and Y. G. Pelovski, 2011. Granulation study of composite mixtures on the basis of ash from burned wooden biomass, for production of soil conditioners. *J. Univ. Chem. Technol. Met*. (Sofia). **46** (2): 131-136.

Mladenov, M., Ek. Serafimova and Y. Pelovski, 2011. Examinations on granulation of soil-improvers on the basis of biomass ashes. *J. of Environmental Protection and Ecology,* **12 (**4A): 2198-2204.

Nikolov, N. and N. Shaban, 2011. Application of black sea sapropelles as amendment by growing of vegetable crop seedlings*. Bulg. J. Agric. Sci.,* **17** (1): 167-172.

Nikolova, A.G., 1995. The Potassium–nutrition element for crop and quality. International Potash Institute, Basel – Switzerland, p.51.

Nikolova, M. and A. Jordanova, 2000. Spravochnik po torene. *Videnov and son*, Sofia, p. 43 (Bg).

Petkova, V. and I. Poryazov, 2007. Biological Effect of Complex Fertilizer HUMUSTIM on Garden Bean and Brussels Sprouts. *Plant Science (Rasteniev'dni nauki*), **44** (2): 154-158 (Bg).

Pidov, A., At. Zaikov, G. Ceklev, D. Kostov, D. Cholakov, N. Aleksiev and Sl. Bahchevanova, 1995. Zelenchukoproizvodstvo i biznes. *"Agropres",* Sofia – Bulgaria, pp. 31-37 (Bg).

Sapundjieva, Kr., K. Kostadinov, Y. Kartalska, S. Shilev and Ml. Naidenov, 2009. Influence of Mineral Fertilization on the Soil Microbiocenosis in the Rhizosphere of Eggplant. *Plant Science (Rasteniev'dni nauki,* **46** (2): 182-185 (Bg).

Tringovska, I., V. Kanazirska and M. Naydenov, 2008. Influence of Some Bioproducts on the Quality of Tomato Pricked Out Seedlings. *Plant Science (Rasteniev'dni nauki*), **45** (2): 149-154 (Bg).

Tringovska, I. and V. Kanazirska, 2008. Influence of the Bioproducts and the Method of Soil Treatment on the Productivity of Greenhouse Tomatoes. *Plant Science (Rasteniev'dni nauki)*, **45** (2) :155-160 (Bg).

Vasileva, V., T. Kertikov, A. Ilieva and A. Rusenov, 2007. Effect of HUMUSTIM Treatment on the Dry Root Mass and Nodulation of Spring Pea*. Plant Science (Rasteniev'dni nauki),* **44** (2): 159-161 (Bg).

Zdravkov, B., V. Ivanova and Y. Pelovski, 2005. Utilization of FGD Gypsum and Ashes from Thermal Power Stations as Soil Conditioner*. J. of Environmental Protection and Ecology,* **6** (4): 873-878.

Received August, 2, 2011; accepted for printing February, 1, 2012.