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INFLUENCE OF COMPOST MIXTURE ON THE LETTUCE YIELD AND QUALITY FORMATION

Svetla Marinova[1], Elena Zlatareva[1], Nicholas Kathijotes[2], Martin Banov[1]

[1]Institute of Soil Science, Agrotechnologies and Plant Protection "N. Poushkarov", Sofia, Bulgaria
[2] „International Ocean Institute", Limassol, Cyprus

Corresponding author: svetla_mar@mail.bg

Abstract
In Bulgaria there are many natural materials that present an interest for human activity in relation of their use and properties. Five natural products were tested. In base of their quantity and quality characteristics was offered different mixture in various combination of vermiculites, ash from straw biomass, wood biomass and pig manure. The aim of the study is based on the characterization and evaluation of the proposed natural products. Different ratio of mixtures was tested as a soil improver and their impact on yield and chemical characteristic of plant production. Pot experiment with lettuce is set out in the following versions: control, 2, 5, 7, and 11% by soil weight. The highest yield is obtained in variants with 11% of all compost mixture. In mixtures (2, 3 and 5) with large manure content has been observed highest increase of yield as a result of more imported nutrients by organic manure. Chemical characteristics of lettuce crop production, with the participation of all variants of compost mixtures show that the main nutrients - nitrogen, phosphorus and potassium are normal for plant species. The level of tested heavy metal is below toxic concentration. The results of total sugars content and photosynthetic activity correspond with data obtained in biomass harvesting in pot experiment. In all variants with 7-11% compost mixture was observed the highest level of photo-synthetically active chlorophyll "a".

Keywords: vermiculite, greensand, straw ash, pig manure, pot experiment.

Introduction

In order to ensure the positive balance of nutrients and organic matter in the soil, it is necessary to use high quality fertilizers. Due to shortage of organic fertilizers in our country, in order to increase fertility, yield and quality of agricultural production, it is necessary to seek new organic reserves. In our country there are many natural materials that represent an interest to human activity associated with the use of their properties in agricultural practices. Several studies have shown that there are natural products which, under certain conditions alone or in combination, can improve the physical and chemical properties of soils and crop yields. Such natural products are vermiculite, greensand, plant ash, wood biomass, etc. which improve the properties of soils (Marinova et al. 2012, Mitova and Marinova 2012).Many studies (Pestnikov, 1990, Vasiliev, 2009) found that greensand is not only a source of microelements (K_2O from 3.7% to 4.4%, P_2O_5 from 0.41% to 0.92%) as plant nutrition and also a material how improves soil structure and soil moisture storage.Plant ash has alkaline properties, removes the acidity of the soil and helps to mineralize nitrogen from humus and in practice is not depleting resources (Nikolova et al. 2010). Biomass of wood is composed of an organic substance synthesized in the process of development of microorganisms, plants and animals. In practice, it is used as a raw material for bioenergy and in the preparation of compost mixes for plant breeding (Brezin et al. 2013).In order to enhance their effect and the content of the main nutrients, it is necessary to compose them with organic products, rich with macro and microelements and this kind of product is the organic manure produced by different species and groups of animals. Along with the macro elements - nitrogen, phosphorus, potassium, large amounts of organic matter and billions of microorganisms are introduced through it, which increase the soil biogenicity and improve the nutrition of the plants (Lampkin, 2002, Marinova, 2013, Sutton et al.

1999). The aim of the study is on the base of the characteristic and the evaluation of the prepared compost mixtures from natural products, to show their impact over the soil properties in pot experiments.

Material and methods

Several natural products - vermiculite, greensand, straw ash, wood biomass and pig manure - are presented for study and evaluation. Based on their qualitative and quantitative characteristics were offered different combinations for use in agricultural practice. After tests of chemical and agrochemical characterization of the starting materials, several compost samples were prepared by mixing in the following ratio:

Table 1. Compost mixture in different ratio

Compost №	Vermiculite	Greensand	Ash from straw	Wood biomass	Pig manure
1.	1	1	1	1	1
2.	1	2	1	1	2
3.	1	1	2	1	2
4.	1	1	1	2	1
5.	1	2	2	1	3

A pot experiment was conducted with prepared mixtures on alluvial meadow soil, using 3 kg pots in three replicates. The alluvium meadow soil is low acid with pH in water 5,8; with low humus content and with worse agro-chemical characteristics compared to leached Smolnitsa. It is low reserved with common nitrogen – about 0,1%, middle reserved with moveable potassium 15,5 mg K_2O/100g and good reserved with moveable phosphorus - 21,9mg/100g. By this kind of soil the content of determined heavy metal is under the limited allowed concentrations (in accordance with № 3 Regulation). The pot experiments are made by the following control variants, soil and addition of 2, 5, 7 and 11% of different mixture, added to the weight of the soil. Test crops by the pot experiments are maize silage and lettuce variety Djentli, because the leafy vegetable crops are particularly suitable as indicators for testing certain factors (Mengel and Kirkby 1982). In the plants tissues, total nitrogen was determined by the Keldahl method - decomposition with concentrated H_2SO_4 and 30% H_2O_2.Macro and micro elements are identified by the "dry" burned in a muffle furnace and subsequent dissolution in 20% HCl, followed by measuring on Atomic Absorption Spectrophotometer. In the study, the chlorophyll was determined in fresh mass (mg %), spectrophotometrically in 80% acetone leaching by the Vernon method, 1960. The total sugars content was determined refractometrically (%) (Digital Refractometer – 32145).

Results and discussion

The determination of the chemical and agrochemical characteristics of the compost mixtures is an important point in determining of the impact on yield and crop production. The yield of lettuce on alluvial-meadow soil with different compost mixtures and different ratio is presented in table2.In general, the difference in lettuce yield for each variant is not significant, because there aren't found significant differences in the chemical characteristics of the individual compost mixtures. It was found that the yield increase in all studied variants in compared to the control. Variation of yield values for individual replicates is noted. In the mixtures III and V with greater input of manure and wood biomass, which is a main product that carrying out the essential nutrients the higher increase of yield was observed. The trend observed in all variants is a gradual increase in yield with an increase of percentage of composite mixtures. The highest yield was obtained in the 11% variant, but the data at the 7% lower rate also showed satisfactory results (table. 2).

Table 2. Yield of lettuce grown on alluvial meadow soil in g/per pot

Lattuce	I replication	II replication	III replication	Average
Controlee clean soil	8,0	5,7	4,5	6,0
First mix in ratio 1:1:1:1:1				
2%	6,7	10,7	5,8	7,5
5%	9,0	12,9	12,3	11,4
7%	11,4	20,1	15,0	15,5
11%	13,9	13,8	20,0	15,9
Second mix in ratio 1:2:1:1:2				
2%	10,0	16,3	14,4	13,5
5%	9,7	11,8	15,3	12,3
7%	11,8	16,9	16,3	15,0
11%	12,3	13,5	15,3	13,7
Third mix in ratio 1:1:2:1:2				
2%	7,4	17,5	8,1	11,0
5%	19,3	12,1	18,9	16,7
7%	9,3	18,3	18,0	15,2
11%	10,6	26,1	12,5	16,4
Fourth mix in ratio 1:1:1:2:1				
2%	7,2	9,8	10,8	9,3
5%	8,2	13,7	16,0	12,6
7%	4,8	24,4	12,4	13,8
11%	11,3	21,7	13,4	15,4
Fifth mix in ratio 1:2:2:1:3				
2%	7,9	11,2	10,2	9,8
5%	13,1	11,0	19,5	14,5
7%	11,5	13,5	12,2	15,4
11%	18,8	18,0	21,1	19,6

Table 3. Chemical characteristics of the lettuce plant production of the alluvial meadow soil experiment

Variant	N %	P %	K %	Ca %	Mg %	Zn mg/kg	Cu mg/kg	Mn mg/kg
Control clean soil	0,41	0,33	3,7	1,17	0,36	31	4	87
Imix 2%	0,30	0,21	3,4	1,00	0,30	27	6	88
5%	0,38	0,20	3,2	0,91	0,28	25	5	66
7%	0,42	0,18	3,0	0,88	0,28	25	5	42
11%	0,46	0,16	3,0	0,46	0,16	10	4	27
II mix 2%	0,30	0,30	4,5	0,84	0,26	35	5	68
5%	0,45	0,31	4,9	0,85	0,26	40	6	51
7%	0,53	0,31	5,3	0,85	0,30	40	6	51
11%	0,60	0,45	7,5	0,90	0,35	34	6	51
IIImix 2%	0,48	0,33	4,8	0,99	0,27	32	7	49
5%	0,50	0,33	5,0	0,98	0,25	35	6	45
7%	0,58	0,37	5,6	0,95	0,25	40	6	45
11%	0,68	0,40	7,3	0,85	0,25	44	5	41
IV mix 2%	0,47	0,37	6,0	0,69	0,25	31	3	65
5%	0,55	0,33	6,5	0,70	0,25	31	3	60
7%	0,62	0,30	6,2	0,82	0,25	30	4	43
11%	0,84	0,26	5,8	0,92	0,25	29	5	28
Vmix 2%	0,50	0,33	5,5	0,60	0,25	0,30	4	25
5%	0,51	0,35	5,8	0,62	0,25	0,30	4	25
7%	0,55	0,35	6,6	0,68	0,26	0,30	5	26
11%	0,59	0,45	7,2	0,75	0,28	30	4	28

From the lettuce plant analysis, it appears that as the mixture rate increases, the total nitrogen, phosphorus and potassium content in the vegetable mass also increases. The P content in plants is from 0.16 to 0.45%. The K content ranges from 3.0 to 7.3%. There is no clearly expressed pattern for content of heavy metals in plant tissues compared to the control. Lead and cadmium have the same values for all variants <0.1. Heavy metals in lettuce in all variants are below the allowable concentration. The content of sugar in aqueous solution (Brix%) is an important indicator as it can determine the growth of plants. When we measure the sugar levels in plants it directly corresponds to how much sugar production has taken place in the plant. The measured sugar levels in lettuce from the vegetation experiment directly correspond to the plant development.

Figure 1.Total sugars content in plant tissue from pot experiment with lettuce grown on alluvial meadow soil

In all variants was observed increasing of the total sugars content in compared to control variant, ranging from 4,9 to 10,4%.There is a trend for increase the total sugar content with increasing the percent proportions of the composite mixture. In the case of a mixture №III with higher pig manure content, the highest sugar content was reported at a 7% ratio per soil weight. Photosynthesis is a physiological process inherent in photoautotrophic green plants. It is a system of reactions in which chlorophyll-containing organisms use light energy and from simple inorganic substances they synthesize organic compounds and emit oxygen. Plastid pigments are organic compounds that absorb light energy with a wavelength of 390-1100 nm. The pigment system consists of several types of pigments: chlorophylls, carotenoids and others. The content of plastid pigments is an important factor determining the growth and development of plants. As an indirect indicator, it can be related to the absorption of nutrients and, above all, nitrogen. Therefore, the determination of the content of chlorophyll "a", "b" and carotenoids is important for monitoring the response of plants to fertilization with different compost mixtures.

The measures carried out for plastid pigments content in lettuce leaves growing on alluvial meadow soil varied between 5,65 to 13,92 mg / l of chlorophyll "a" and between 4,01 and 9,65 mg / l of chlorophyll "b". For all variants of the compost mixtures, the ratio 2: 1 for chlorophyll "a" and "b" is retained. The lettuce reaction clearly shows an increase in the levels of plastid pigments relative to the control. Corresponding with sugar content and yield, the highest levels were recorded in 7-11% variants of the compost mix over the weight of the soil. Higher content of chlorophylls has been reported for compost 5, due to the high nitrogen content incorporate in soil with the pig's manure, which is the largest amount of soil weight. Due to the presence of different nutrient content in individual mixtures, the increase is particularly related with pig manure from livestock farms.

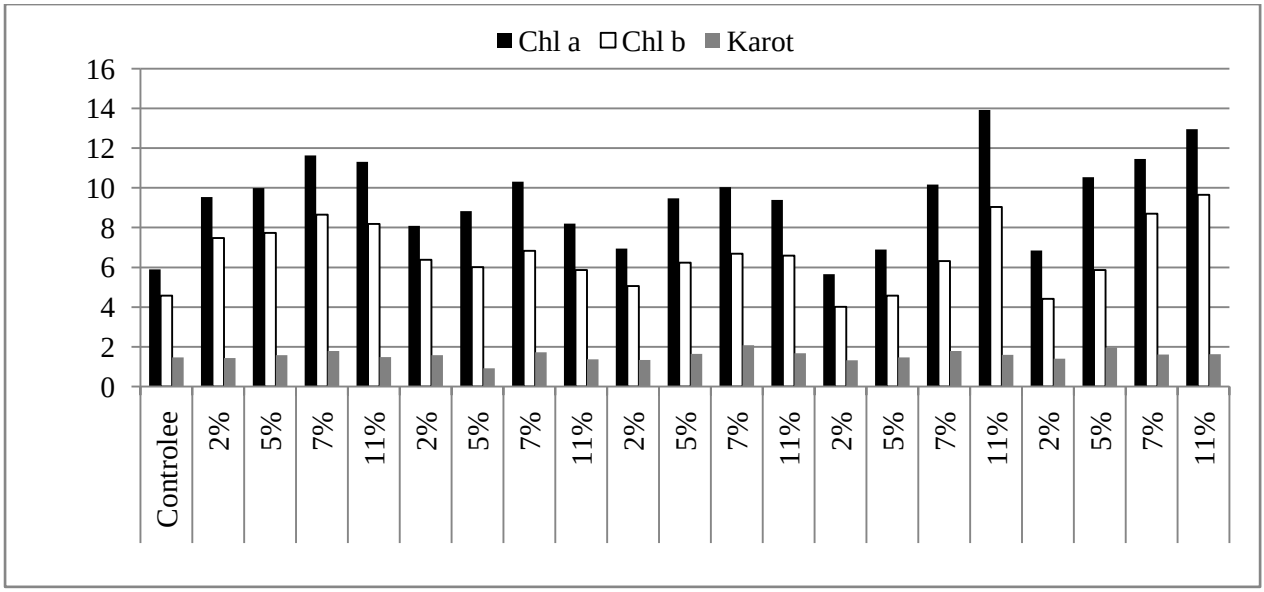

Figure 2.Content of plastid pigments in pot experiment with lettuce grown on alluvial meadow soil

Conclusions

The reported lettuce yield grown on alluvial meadow soil, shows that there is a gradual increase in yield, depending on the ratio of the mixtures in compared to the control. The highest yield was obtained in the 11% variant, but the data at the 7% lower rate also showed satisfactory results. In the variants of mixtures with a larger share of manure - II, III and V there is a general tendency of yield increase as a result of more nutrients input with the manure. The chemical characterization of plant production on alluvial meadow soil involving all compost mixtures and variants shows that there are no significant differences in the values of macroelements and heavy metals relative to the control. The results obtained for total sugars content and photosynthetic activity corresponds to the data obtained for the lettuce yield. The data confirm that photosynthetic potential is closely related to nitrogen feed and yield. The high levels of chlorophylls reported at an earlier stage of plant growth are the guarantor of higher and sustainable yields. In all composite mixtures, the best results for the photosynthetic active chlorophyll content "a" are showing at 7-11% of the blends.

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