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Use of organic materials of different genesis for improvement of physical properties of soils

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Abstract. Structure-forming properties of various types of peat, siliceous and organic types of sapropel, brown coal, ameliorant, biohumus, manure and humic preparation have being studied with the friable sandy soil and soddy podzolic clay loam one.

Improvement of sandy soil structure was registered for all the experiments; however the degree of each material influences on soil structure varied. Biohumus and humic preparation showed the better results where the sum of valuable aggregates increased for 7 %.

Influence of kaustobioliths on structural-aggregate composition of clay loam soil was more considerable and the increase of amount of aggregates with the same size reached 10 %. The greatest increase of aggregates amount and their water durability took place when ameliorant or biohumus was introduced into soil.

Key words: Peat, Sapropel, Ameliorant, Biohumus, Humic Preparation, Soil Structure

Introduction

Problem of improvement of adverse properties of sandy and sandy loam soils, widespread not in Belarus only (where they occupy over a half of arable lands area) but in many other countries of the world is rather critical. The prevalence in granulometric composition of light soils of particles, which is larger than 0.01 mm and low contents of colloidal fraction causes inability to formation of soil aggregates and agronomically valuable structure**.**

The presence in many countries of essential areas of low fertile sandy, sandy loam soils and broken grounds has an effect for productivity of agricultural crops in the first

and predetermines the complex required ways and effective means for improving soils fertility and restoration of the broken territories in second.

The poor harvest on light soils in comparison with heavier ones is caused not only by their natural poverty of nutrients, but also low contents of humus and colloidal particles. It is evident positive multilateral influence of organic fertilizers on properties of soil. They improve microbiological activity of soil, stimulates development of agricultural crop, serve a source of organic substance for humus formation etc.

Increase of agronomical value of soil structure, its preservation and improvement are directed first of all on creation of optimum aggregate composition, increase of mechanical durability and water stability of aggregates.

The special meaning the structure gets at influence on air, water and nutritious regimes, formation of biological activity.

Major sources of updating stocks of organic substances in soil are organic composts and fertilizers, peat, sapropel and products on their basis.

The goal of this study was to investigate the structure-forming properties of various kinds of kaustobioliths and products on their base on agro physical properties of two light granuliometric composition soil varieties.

Materials and Methods

As objects for study of structure-forming properties of various kinds of kaustobioliths and products on their basis were taken sandy-gravel mixture and soddy-podzolic light clay loam soil.

The design of experiments was as follows: soil – control; soil+low peat; soil+high peat; soil+siliceous sapropel; soil+organic sapropel; soil+brown coal; soil+ ameliorant; soil+biohumus; soil+ manure; soil+humic acid.

The experiments were carried out in polyethylene vessels of 6 litres volume in replication 4. The doze of entering each of studied materials was equivalent to the rate of 30 t ha^{-1} on dry weight. During experiment conducting the humidity at a level of about 70 % from complete moisture capacity was supported. Periodicity of soil physical parameters determination in dynamic was two times a year.

Ploughing lay of clay loam soil was characterized by sub acid reaction of a soil solution, the contents exchangeable forms of phosphorus and potassium were equal 215-360 and 175-230 mg kg^{-1} of soil.

The particles of sand (size of fractions 1-0.5mm, 0.5-0.25mm and 0.25-0.05mm) prevail in sandy-gravel material. Among fractions of sand the greatest amount belongs to

particles of medium sand – 41.1 %. Quantity of physical clay, which made 5,0 % governs friable sandy granulometric composition of that substrate. The firm phase density was 2.65 g/cm^3, hygroscopic moisture – 1.4 % and complete moisture capacity – 15.6 %.

Results and discussion

Changes in amount of aggregates received by dry sifting by Savinov's method testify about improvement of sandy-gravel material structure practically for all variants of experiment as a result of various kaustobiolths interaction with it. But the degree of influence on modular structure was depended on a kind of used material. Most effective appeared to be biohumus, humic acid and manure - the sum of agronomically valuable units (size from 10 to 0.25 mm) has increased for 7 % in comparison with control.

It is necessary to note that liming had not resulted in substantial growth of a degree of structuring sandy-gravel material. Nevertheless results of the analysis on control variant and variant with biohumus and organic sapropel application testify to influence of soil acidity on formation of structural unites.

It was shown that structure-aggregate composition of soddy-podzolic clay loam soil was improved essentially when biohumus, ameliorant, humic acid and manure have been applied. The increase of the sum of agronomically valuable units on these variants has made 5-7 %. Most typical changes of amount of units were submitted by larger fractions.

As a result of structuring effect of ameliorant, biohumus or cattle manure the reduction of quantity of units with the size less than 0.25 mm observed. The reduction has made from 6 up to 9 %. Introducing into soil of humic acid promoted increase of amount of units by the size less than 0.25 mm.

As it is known agronomically valuable structure is considered as water stable with high porosity soil structure.

In our experiments water stability of soil units of clay loam soils determined by a method of wet sifting by N. Savvinov (Figure).

The main changes in water stability of structural separateness were observed in larger fractions i.e. more than 5 mm, 5-2 mm and 2-1 mm. Water stable units of a fraction more than 5 mm were absent completely in variants with peat, sapropel, ameliorant and brown coal application. Interaction with soil of biohumus, humic acid and semi liquid manure promoted formation of water stable units of this fraction. The formation of water stable aggregates by the size of 5-2 mm was promoted by entering wider

spectrum of studied materials as sapropel, ameliorant, brown coal, biohumus, manure and humic acid.

In creation of water stable units of a fraction by the size 2-1mm in the greater degree structure forming action was shown by biohumus and semi liquid manure. The increase made 22 and 17 % accordingly in comparison with 7 % on control variant.

The precisely expressed tendency in increase of amount of water stable units of more fine fractions did not reveal.

For an agronomical estimation of stocks of moisture and definition of a range of productive moisture in soil the large practical importance has humidity of steady wilting (HSW). We have tried also to determine influence of kaustobioliths and products on their basis on changes of this characteristic and also on value of maximal hygroscopic humidity (MHH) and complete moisture capacity (CMC). The data submitted in Table 1 testify that introducing studied materials in sandy gravel mix has not affected such hydrological constants as a humidity of steady wilting and maximal hygroscopic humidity. At the same time complete moisture capacity had undergone to significant change and bigger increase of moisture capacity appeared to be in variants with peat, sapropel, brown coal and ameliorant application (5.5-6.7 % to control).

The positive influence of various kinds of organic matter on physical soil properties resulted in changes of complete moisture capacity. This parameter increased practically in all variants except for variant with siliceous sapropel adding. The increase made from 3 up to 7 %.

Favourable physical regime in soil is created due to presence not micro aggregates only but microstructures also. The influence of organic material of a different kinds on micro aggregate composition of sandy gravel mix is submitted in the table 2.

The results of interaction of different materials with sandy gravel ground and with clay loam soil were different. The tendency of increase of quantity of microunits of larger size observed practically in all variants with clay loam soil test. Quantity of microunits with the size up to 0.1 mm increased considerably and that increase depended on a kind of organic substance. So, at entering into soil manure the amount of units of 1-0.1 mm increased till 41 % of dry weight of soil, while interaction of other materials with it resulted in their increase reached from 21 to 28 % in comparison with 17 % on control variant. It should be stressed that there was a reduction of quantity of microunits of the size 0.1-0,05mm and 0.05-0.01mm on this background.

Monitoring the changes of soil density has shown that introducing organic substance (even in so comparatively small doses) into ground reduced density of clay loam soil. The reduction of soil density was most appreciable on variants with entering peat,

biohumus, manure and humic acid. It is necessary to note that as the experiments was carried out in polyethylene vessels the density of soil as a whole was much lower than that of soil in field conditions (Table 3).

CONCLUSIONS

As a results of two-years study it is possible to make conclusion that organic materials of different nature and the products produced on their base render structure forming action on sandy gravel mix and soddy podzolic clay loam soil. Application of studied materials resulted in increasing quantity of agronomically valuable aggregates of the size of 10-0.25 mm and as the consequence of it complete water capacity increased also. The appreciable reduction of clay loam soil density observed in variants with peat, biohumus, semi liquid manure and humic acid application.

Introducing such materials as biohumus, sapropel, ameliorant, humic acid and semi liquid manure in soil promoted formation water stable aggregates of large fractions.

Application of manure, sapropel, humic acid, biohumus or brown coal resulted in increase of content of micro aggregates in soil essentially.

As far as structure forming processes development in soils requires rather long period of time and alongside with organic substance depends on climatic and other factors the more long observations under different conditions required to be done and of great importance in fact.

1 Table 1 Changes of hydrological parameters

Object of researches	Parameter	Control	Peat of low type	Peat of high type	Siliceous Sapropel	Or
SANDY GRAVEL MIX	**HSW**	**1.5**	**1.7**	**2.0**	**1.9**	**2.0**
	MHH	**0.6**	**0.7**	**0.8**	**0.8**	**0.8**
	CMC	**15.7**	**18.4**	**22.3**	**17.2**	**21**
CLAY LOAM SOIL	**HSW**	**7.0**	**7.2**	**6.7**	**7.5**	**7.8**
	MHH	**2.8**	**2.9**	**2.7**	**3.0**	**3.1**
	CMC	**39.1**	**42.5**	**43.1**	**40.5**	**43**

Table 2: Micro aggregate composition changes of sandy gravel mix and soddy-podzolic clay loam soil

(pipette method, % to dry weight of soil)

VARIANTS OF EXPERIMENTS	**SIZE OF FRACTIONS, MM**			
	BIGGER THAN 0.1	**0.1-0.05**	**0.05-0.01**	**0.01-0.005**
CONTROL	**16.5/81.4**	**37.5/8.7**	**52.4/4.9**	**5.7/2.2**
PEAT OF LOW TYPE	**16.2/84.2**	**26.0/9.1**	**51.3/2.6**	**5.2/1.7**
PEAT OF HIGH TYPE	**21.5/83.8**	**22.0/8.6**	**50.3/3.2**	**5.4/1.6**
SILICEOUS SAPROPEL	**25.4/82.9**	**21.1/8.0**	**48.6/4.2**	**4.4/1.8**
ORGANIC SAPROPEL	**20.9/83.7**	**33.2/8.0**	**49.4/3.5**	**4.6/2.1**
BROWN COAL	**23.8/83.8**	**22.2/8.0**	**48.6/3.1**	**4.9/2.3**
AMELIORANT	**18.6/84.0**	**29.5/7.5**	**46.0/3.8**	**4.6/2.0**
BIOHUMUS	**21.1/83.6**	**20.3/7.9**	**52.4/3.1**	**5.4/2.5**
SEMI LIQUID MANURE	**41.0/80.6**	**15.8/11.7**	**38.6/3.7**	**4.3/1.7**
HUMIC ACID	**28.1/82.7**	**16.3/10.7**	**49.8/2.9**	**4.0/1.4**
NOTES: IN NUMERATOR – CLAY LOAM SOIL; DENOMINATOR – SANDY GRAVEL MIX				

Table 3 – Clay loam soil density changes, g/cm^3

CONTROL	PEAT OF LOW TYPE	PEAT OF HIGH TYPE	SILICEOUS SAPROPEL	
FIRST DETERMINATION				
1.12	**1.08**	**1.06**	**1.15**	
Second determination				
1.08	1.06	1.09	1.11	
On the average				
1.10	1.07	1.07	1.13	