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Neutralization of Peat for Substrates Preparation , Using Black Sea Organo-mineral Sediments (Sapropels)

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Abstract

Peat is a ground component in various substrates for seedling production. Because of content of organic acids in the peat it has to be neutralized before using. In the period May-June 2014 was carried out neutralization of peat from Lituania, using Black sea organo-mineral sediments – sapropels. The results obtained were compared to control – peat without sapropels and etalon – neutralized with powdered calcium carbonate peat. Incorporated in the peat the marine sapropels increase pH values as follows: At an amount 10 g/kg from pH 3.76 (control) to 4.85 at the first day, 5.24 after four days incubation, 5.41 after 11 days and 5.47 after 28 days. At an amount 30 g/kg at the same incubation periods to pH 4.92, 5.49, 5.77 and 5.93. At an amount 50 g/kg respectively to pH 6.37, 6.42, 6.47 and 6.58. At an amount 70 g/kg respectively to pH 6.90, 7.01, 7.18 and 7.23. At an amount 100 g/kg respectively to pH 7.08, 7.15, 7.19 and 7.28. By using calcium carbonate as etalon pH changes as follows: At an amount 10 g/kg from pH 3.76 (control) to 5.13 at the first day, to 5.33 after four days incubation, 5.42 after 11 days and 5.45 after 28 days. At an amount 50 g/kg respectively to pH 7.23, 7.27, 7.33 and 7.39. At an amount 100 g/kg respectively to pH 7.32, 7.41, 7.43 and 7.56, compared to control (pH 3.76).

Key words: marine sapropels, marble powder, peat moss, electrical conductivity, calcium, magnesium.

Abreviations:
EC - electrical conductivity,
Na_2EDTA - disodium dihydrogen ethylenediaminetetraacetate
CEC - cation exchange capacity

Introduction

Peat is an essential component in various nutrient substrates, widely used in greenhouse production of vegetable crops, hydroponics, seedlings and flowers production etc. It is formed by the slow and gradual decomposition of marsh plant residues. According to Malmer et all (2011) in agreement with Burrows et all (2014) this process occurs under anaerobic conditions and represents the first stage of carbonization. Peat contains some macro- and micronutrients such as nitrogen, potassium, phosphorus, iron, manganese etc. In fact from nutrients peat contains substantially only nitrogen to 20-25 kg/t, but plants absorb it very poorly. As a rule are absorbed only 3% - 5% of nitrogen, or 0,6 - 1.0 kg/t. According Grootjans et all (2014) about three percent of the Earth's surface is covered with peat bogs that have developed over thousands of years. Finland has the most extensive peat bogs in the world, followed by Canada, Ireland, Sweden and others. Canada is a world leading manufacturer and exporter of peat. Presence of fiber in the composition of organic matter increases the porosity, which is associated with better aeration and moisture preservation of soil. The organic matter in composition of the marsh peat improves assimilation of nitrate and ammonia nitrogen by plants. Peat has a strongly acidic reaction which is in range of 3.5-4.4 pH units, depending on its type and the reservoir from which it is produced. The acidic peat is used as an improver of calcareous soils with a weakly alkaline and alkaline reaction - pH 7.5-9.0. In all other cases before use the peat has to be neutralized to weakly acidic or neutral reaction (pH 5.5-7.0), depending on the intended use of peat-perlite or peat-soil mixture, and the type of grown culture (seedlings). The neutralized peat is used as a component in various substrates, and as an improver of topsoil at fruit and ornamental plants. To neutralize peat are used various powdered lime ameliorants as hydrated lime, calcium carbonate and dolomite. According Dimitrov et all (2000) these ameliorants can not provide long-term stabilization of pH (2-3 years), especially when is applied intensive usage of acidic fertilizers, such as ammonium nitrate, ammonium sulfate and others. Pure peat is most effective in poor non-cultivated sandy or clay soils with low organic matter - 40-50 g/kg humus. It improves soil structure, which is associated with higher moisture retention capacity of soils- factors that largely depends on soil fertility. Humic acids in the peat composition stimulate a plant growth. According to Nikolov (2011) peat-perlite substrates, enriched with marine sapropels are most suitable for rooting of mature clips of Kazanlika oil bearing rose. Cholakov et all (2003) have used marine sapropels as amendment for peat-manure substrates, to grow tomato seedlings with more higher biologycal potential and resistance against the uvfavorable glasshouse conditions. Peat is resistant material - well keeps the nutrients in its composition, so that it can be introduced at any time of the year in the soil.

The aim of present work was to explore the possibility of neutralization of the strong acidic peat from Lithuania, using deep water Black sea organo-mineral sediments - sapropels, with a view to its more efficient application in various aspects of agricultural practice.

Materials and Methods

1. **Neutralization of peat**

This research was carried out during the period May-June 2014 under laboratory conditions in Plovdiv research Institure for Vegetable Crops "Maritza". The peat used in the experiment was unfertilized sphagnum peat moss from Rekyva, Lithuania (Agro Export Import Ltd) with $pH_{(H2O)}$ – 3.76. Peat samples of 115 g were set in plast pots with volume of 0.50 dm^3 (5 L peat have a weight 1.15 kg) and mixed with Black sea sapropels in an amount 10, 30, 50, 70, and 100 g/kg. Periodically was performed moisten the peat with drilling, unchlorinated water. For comparison as etalon lime ameliorant was used marble powder, fraction 0,01-0.05 mm, (QSS-Sofia LTD) with following chemical composition: CaO – 49.8%, MgO – 5.6%, SiO_2 – 2.24%, Fe_2O_3 – 0.99%, Al_2O_3 – 0.48% and K_2O – 0,42%. It was introduced in amounts 10, 50 and 100 g/kg. As control sample was used pure peat (115 g) without ameliorants. Every variant including control sample was carried out with 10 plast pots, as total number of pots was 90. The following parameters of the samples were measured: pH, EC (ms/cm), content of calcium and magnesium (ppm). Analyses were performed in duplicates in aqueous extracts 1:1.5 (v/v) (Soneveld et al., 1974).

2. Chemical composition of Black sea sapropels

Sample used Black sea organo-mineral sediments (sapropels), taken from a depth 1200 m, according to Nikolov (2014) has the following chemical composition: SiO_2 - 397,6 g/kg, CaO – 154.6 g/kg , MgO – 26.8 g/kg , Na_2O - 21.3 g/kg , K_2O - 18.3 g/kg, TiO_2 - 7,0 g/kg, P_2O_5 - 1,32 g/kg, N – 25.4 g/kg, $A1_2O_3$ - 116.9 g/kg , FeO - 45.7g/kg , MnO - 0.4g/kg , Cr – 50.0 g/t , Mo - 36,40 g/t, Zn - 65.82 g/t , Mn - 383,42 g/t , Cu - 36,63 g/t , Ni - 49.75 g/t total C - 199.7 g/kg, humus content – 68.5 g/kg.

2. Determination of Ca and Mg.

Sample of pure dark peat was analyzed complexo-metrically with Na_2EDTA for a content of Ca and Mg(g/kg). The content of Ca and Mg in the samples of peat-sapropels and peat-etalon mixtures were determined by calculation, based on their content in the output ameliorants and quantity in which they were imported in the samples.

Fig.1 Lithuanian peat moss

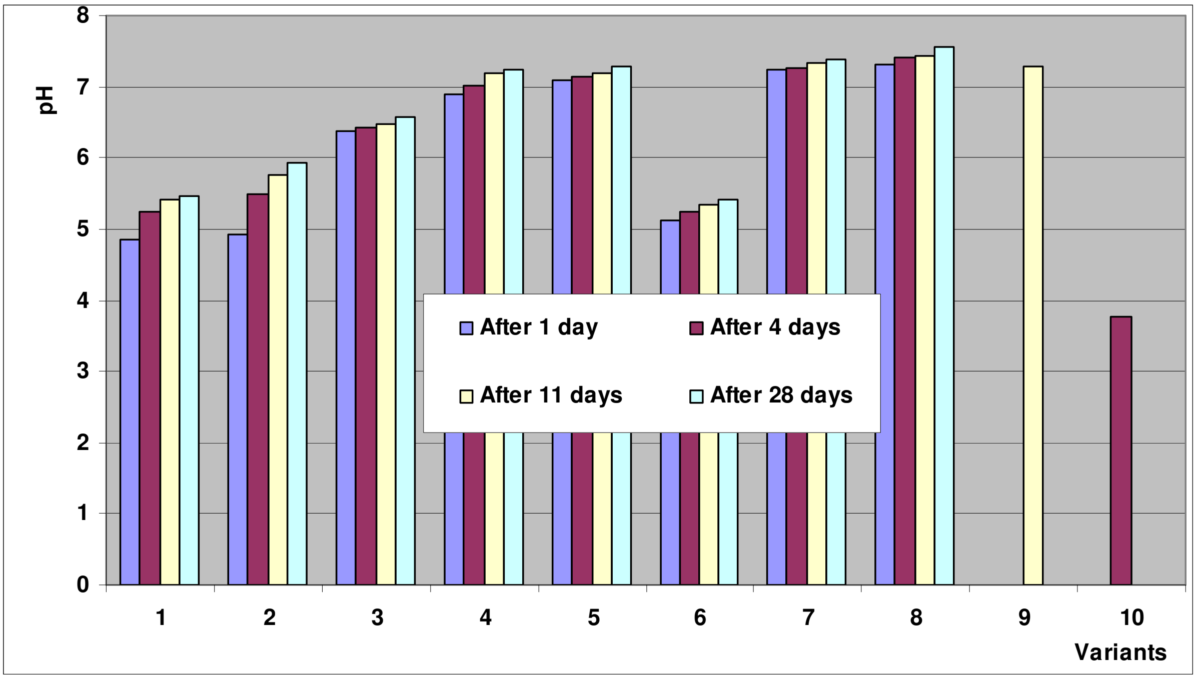
3. Determination of pH. The pH values in water medium of the analyzed samples, pure sapropels and control sample (peat) were determined with a pH meter, Model WTW, Germany, (ISO 10390).

4. **Determination of EC.**

EC (mS/cm) of the analyzed of peat, peat-sapropels and peat-etalon mixtures in aqueous extracts 1:1.5 (v/v), was determined with conductivity meter. (WTW, Germany)

Results and Discussion

The pH change in samples with different content of sapropels is shown in fig.2., At an amount 10 g/kg pH changes from 3.76 (control) to 4.85 after 1 day incubation to 5.47 after 28 days. The obtained data show that the dependence between the amount of incubated sapropels and the pH value is directly proportional, as the most significant difference was reported a day after incubation of sapropels in the studied black peat.



Legend: Variants 1-5. Content of sapropels : 1. 10 g/kg, 2. 30 g/kg, 3. 50 g/kg, 4. 70 g/kg , 5. 100 g/kg, Variants 6-8. Content of marble powder: 6. 10 g/kg, 7. 50 g/kg, 8. 100 g/kg, 9. Pure sapropels, 10. Control

Fig.2. Values of $pH_{(H2O)}$ in peat mixtures with ameliorants, pure sapropels and control

Table 1. Electrical Conductivity (EC) of peat and its mixtures with ameliorants in water solution

Samples	Content of ameliorant		Electrical conductivity after days (mS/cm)			
	Variant	g/kg	1	4	11	28
Peat-sapropels mixtures	1	10	0,24	0,27	0,33	0.34
	2	30	0,31	0,38	0,39	0,44
	3	50	0,37	0,41	0,46	0,52
	4	70	0,48	0,60	0,63	0,66
	5	100	0,59	0,83	0,86	1,06
Peat-etalon mixtures	6	10	0,27	0,28	0,28	0,31
	7	50	0,34	0,33	0,40	0,39
	8	100	0,39	0,42	0,43	0,45
Peat	10	-	0,19			

After the first day pH increased insignificantly, especially at the variants with 50, 70, and 100 g/kg incubated sapropels - from 0.2 to 0.3 pH units. At the first two variants (10 and 30 g/kg) the pH change was from 0.6 to 1.0 pH units. The pH values 6.58, close to neutral medium was reached after 28 days incubation at variant 3 – 50 g/kg sapropels. By more higher contents of sapropels - 70, and 100 g/kg, pH increase to values 6.90 pH units in the beginning of incubation to 7.23 after 28 days, and from 7.08 to 7.28 pH units respectively(fig.2) At the etalon used pH close to neutral medium was established at variant 2 – 50 g/kg marble powder – 7.23 pH units after the first day. The most significant difference was reported a day after

incubation of the lime ameliorant in the studied peat. After that pH value changes insignificantly. The differences at the three tested concentrations were in the range 0.16-0.34 pH units. Sapropels used have weakly alkaline reaction – pH 7.23.(fig.2) According to Nikolov (2014) the sapropels neutralize the acidity of some soil types, due to their high buffering capacity. The content of humic acids in the form of alkaline salts in the sapropels composition is an important factor for increasing of basic exchange ions and decreasing the content of Al^{3+} and H^{+} . The data from fig.2 show that even in minimum quantities (50 g/kg) the marine sapropels neutralize the acidity of the strong acidic peat to value close to neutral medium -pH 6,58.

Peat moss as a special kind of soil has low EC, which according to Theimer et all (1994), in agreement with Ponziali et all (2011) depends on the content of water in the pores of the peat and the concentration of total dissolved solids. Exists linearly correlation between EC and the content of water soluble substances. EC according to Scott (2006) depends on the temperature and affected by other properties of the materials like CEC, heterogeneity, organic content, structure (peat porosity), pH and water content. The EC values of the tested samples are shown in table 2. Most expressed was the influence of sapropels content in the peat samples, compared to the content of powdery marble used as etalon. In comparison with control sample (0.19 mS/cm) EC of the peat-sapropels mixtures increased slowly to the end of incubation period, depending on the content of sapropels. At variant 1 (10 g/kg) this increase was in borders 0.24-0.34 mS/cm from the beginning to the end of the studied period. EC reaches most higher value in variant 5 from 0.59 mS/cm after the first day to 1.06 mS/cm after 28 days incubation. The reason for more higher EC is related to increase of ions content, due to interaction and ion exchange processes between the humic acids in the peat and salts of the basic elements entering in the composition of marine sapropels. At the etalon variants - peat-marble powder mixtures there were no significant differences between the EC values in the beginning and the end of the studied period. The changes were in borders 0.04-0.06 mS/cm, which is in the frames of the analytical mistake. The values of variant 8 (100 g/kg marble powder) – from 0.39 to 0.45 mS/cm are significant more lower, in comparison with the corresponding values of variant 5 (100 g/kg sapropels) - 0.59-1.06 mS/cm.(Table 1)

The content of calcium and magnesium in soils and substrates is very important for the soil fertility. Calcium is needed for normal development of the root system and the overhead mass of plants. Not enough content of calcium suppresses their growth. It is important for the physicochemical properties of the soil. Lime ameliorants have a corrective effect on soil acidity and improve soil structure, which is related to the normal feeding regime of plants. Magnezium is very important for the photosynthesis of plants, as it is an essential element in the chlorophyll molecule. The content of Ca and Mg in the studied peat – sapropels and peat - marble powder mixtures is illustrated in table 2. The content of Ca and Mg in the the output black peat is 0.02 g/kg and 0.011 g/kg respectively. The content of Ca and Mg in the peat-sapropels and peat-marble powder mixtures depends linearly on the amount of the relevant ameliorant.

Table 2. Content of Ca and Mg in the peat and its mixtures with sapropels and etalon ameliorant (marble powder)

Sample	Content of ameliorant in the samples		Average data for content of Ca and Mg, g/kg	
	Variant	g/kg	Ca	Mg
Peat-sapropels mixtures	1	10	0.11	0.017
	2	30	0.35	0.063
	3	50	0.57	0.092
	4	70	0.79	0.124
	5	100	1.11	0.173
Peat-etalon mixtures	6	10	3.57	0.350
	7	50	17.9	1.75
	8	100	35.7	3.50
Peat	10	-	0.02	0.011

Conclusion

On the base of results obtained can be drawn the following conclusions:

1. The black sea sapropels can successfully be used for neutralization of the strong acidic sphagnum peat moss in amount 30-70 g/kg depending on the kind of grown culture (seedlings) requiring substrate with pH values within a certain range.

2. The use of marine sapropels in comparison with another lime ameliorants is recommended, because peat substrate enriches with more than 20 useful for the plant vegetation micro- and macro elements. From another side the marine sapropels posses high buffering capacity - the most important factor for long-term stabilization of pH in soils and substrates.

3. The presence of organic matter in the composition of sapropels is a condition for additionaly stimulation of the plant growth, more higher assimilation of nitrogen from mineral fertilizers and favoring development of beneficial microflora in the plant's root system.

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