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NEW SOIL IMPROVING AGENTS FOR ACCELERATED CULTIVATION OF SOILS WITH LOW FERTILITY OR DAMAGED

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A b s t r a c t. The new generation of soil improving agents (the so-called soil conditioners) has been suggested for immediate and complex restoration of the soils damaged by the flood in Central and Eastern Europe in 1997. The new ameliorants are prepared on the bases of peat, sapropel, glauconite and other kinds of natural raw materials. Composition of the soil improving agents depends on their application and can be controlled by the ratio between individual components. Effectiveness of the new soil improving agents was estimated in practical application and field tests on the damaged, desert and cultivated soils in Belarus, the United Arab Emirates and Egypt .

K e y w o r d s: soil fertility, soil improving agents, peat, sapropel, manure

INTRODUCTION

Vast areas of soils were destroyed in the Central and Eastern Europe by the flood of 1997. Several groups of damaged soils were formed as a result of that flood. Among them such main soils as: soils buried by the alluvial layer with low fertility, soils destroyed by water erosion, soils contaminated with heavy metals and soils destroyed by all these factors jointly. However, these newly formed soils require accelerated improvement of their fertility and purification from heavy metals.

The paper proposes application of high quality soil improving agents for the prompt and complex improvement of soil fundamental properties such as agrophysical, agrochemical, microbiological and biochemical features, as well as water, air and nutritive conditions in order to increase fertility of the destroyed soils, newly cultivated lands and those previously cultivated.

The ameliorants are also meant to obtain ecologically clean production of cereals, vegetables, grasses, fruit and other groups of crops.

MATERIALS AND METHODS

The soil improving agents, characterised as completely natural media without any synthetic components, are made of ecologically pure natural raw materials. Composition of different soil improving agents includes the best sorts of peat and sapropel, glauconite, zeolite and phosphogypsum.

Peat is an organic rock which was formed during the period of 3-10 thousand years as a result of incomplete decomposition and humification of dead mire plants in wet conditions. Peat is rich in nitrogen (up to 3-4%) and organic matter represented by natural biopolymers, namely humic acids, fulvic acids, lignin, polysaccharides and others [3].

Sapropels are fine-dispersed deposits of fresh-water lakes. They are mainly formed of dead aquatic organisms. The best types of sapropel are used in the production of soil improving agents. Organic substances constitute not less than a half of their composition which also includes various mineral substances of the

bionic origin which makes them well assimilated by plants. Sapropelic deposits, as well as peat, were formed within the period of 3-10 thousand years. But unlike peat, they contain a total complex of nutritious substances necessary for the plants [2].

Glauconic rocks are enriched in fossilised biochemical stable humus, microelements, potassium, phosphorus and clayey minerals which considerably improve water-retaining and absorbing properties of soils.

Zeolite is a natural product. It is a carcass alumosilicate. It improves physical properties of soils and has a number of agronomic advantages, e.g., good adsorption properties, high ability to exchange ions and retain water. It is most effective on sandy soils.

Phosphogypsum is the product of processing of phosphorous ores from the Kola Peninsula. It mainly consists of calcium sulphate. It also contains up to 3% of the phosphates and microelements available for plants. It reduces harmful effect of high salt concentration and alkaline reaction of the medium on plants. In the former USSR up to 1,5 mln tons of phosphogypsum were used annually for the improvement of saline soils. It also improves physical, biological and agrochemical properties of the soils under cultivation. Summing up we can say that all the components used for the production of organic soil improving agents are ecologically pure natural formations.

Preparation of soil improving agents is carried out commercially, on a special technological installation by means of original technology. Technological layout includes separation and addition of peat, sapropel and other components, including balancing additives, mixing and packing of the finished product. Technological process is flexible and allows to obtain different compositions of soil improving agents depending on the quantity of raw components used. There are 7 kinds of preparations of soil improving agents with different properties according to their application.

Soil improving agents were tested in the field conditions of Belarus, the United Arab Emirates and Egypt with different agricultural and decorative crops on the damaged, desert and old cultivated soils [1].

RESULTS

Organic soil improving agents are in the form of loose bulk material, dark grey in colour and without odour. The size of particles does not exceed 15 mm.

The seven kinds of organic soil improving agents that we produce contain organic matter and mineral components such as nitrogen, phosphorus and potassium available for plants. What is more, they also contain high quantity of biologically active substances and microelements. Dry matter of soil improving agents contains: from 50 to 90% organic matter, from 1.5 to 6% total nitrogen, from 0.6 to 4% of potassium available for plants. In the composition of various kinds of soil improving agents the content of humic and humus-like substances can vary from 20 to 60%, the content of carbohydrates from 6 to 40%, and amino acids - from 3 to 5%. The total content of lipids, waxes, pitches, hormones and other natural biologically active substances stimulating plant growth and development differ from 1.5 to 3.5%.

Each kind of soil improving agents has a constant composition and stable agricultural properties since they are commercially produced.

Organic soil improving agents do not contain pathogenic organisms, vermin or quarantine weeds. Thus, they cannot cause human, plant and animal diseases. They do not contain heavy metals such as lead, cadmium, mercury, arsenic and others. Besides, they have no synthetic components or preservatives. Organic soil improving agents do not have any unpleasant odours. Their application is safe and allows to obtain ecologically clean agricultural products without nitrates or heavy metals.

Thanks to the special technology of production and to the high quality of natural raw-materials, organic soil improving provide plants with all the necessary nutritive elements in optimum proportions during the whole period of vegetation in the first year of application. Some other advantages are:

- homogeneity structure;

- stable composition and balanced content of nutritive elements;
- high content of humic substances;
- natural hormones and other biologically active substances;
- mineral and organic-mineral colloidal particles resistant to decomposition that have a positive effect on the complex improvement of physical, chemical and biological soil properties, soil water and nutritious conditions for a long period of time;
- lack of odour and ecological reliability.

One of the important advantages of soil improving agents as compared to other well-known organic fertilisers is the long-lasting positive effect on the soil. In Egypt the content of humus in the arable layer of the primarily developed desert sandy soil on which three different agronomic cultures were grown was as follows:

- after application of mineral fertilisers (NPK) 0.11%;
- after application of manure compost + NPK 0.23%;
- after application of soil improving agents without NPK 0.61%.

In the case of application of soil improving agents for three to five year periods on the desert soil it is possible to generate an arable layer with humus content of 1.5-2.0%. To achieve this it is not necessary to apply any mineral fertilisers at the same time.

Thus, our soil improving agents have great advantages over well-known soil ameliorants and are very profitable means of improving damaged, desert and cultivated lands.

The soil improving agents have been tested in the experimental fields of the Institute for Problems of Natural Resources Utilisation and Ecology of the National Academy of Sciences of Belarus and in different farms of Belarus.

The results obtained in the field tests carried out on the recultivation of disturbed sandy soil (by excavation of sand-gravel mixture) showed radical improvement of biological, physico-chemical and agrochemical properties of the studied soils expressed in 22-72 % increase of yields from the plots where ameliorant had been introduced when compared with peat, manure or peat-manure compost. The complex efficiency of soil improving agents was essentially higher than that of peat, manure or peat-manure compost.

All the basic components and prototypes of the organic soil improving agents were tested in the United Arab Emirates in 1989-1990 during primary development of desert sandy soils before cultivation of maize, alfalfa, date-palms, citrus plants and mango trees started. Maize was cultivated in 32 variants on the area of 7200 m^2, alfalfa - in 13 variants on the area of 1300 m^2, onion - in 11 variants on the area of 1100 m^2, bamia - in 11 variants on the area of 1100 m^2. Beside that 250 lemons, 150 orange-trees, 250 mango-trees and 11 date-palms were planted. Five-hundred fifty sampels of lemons, orange-trees and mango-trees were planted in a temporary nursery.

After application 60 tons of soil improving agents per 1 hectare of desert sandy soil the yields were 30-50% higher than that after application of manure compost, peat and domestic waste from the UAE.

Results of tests carried out on soil improving agents during a 3 year period in Egypt in the conditions of primary cultivation of desert sandy soils showed that during the first year of application it is possible to obtain 1.8 t/acre of wheat and 12 t/acre of cabbages. It is also possible to obtain high and stable harvest of maize, potato, onion and other agronomic cultures in the subsequent years. These results are compatible with the yields obtained in the delta of the Nile.

Application of special types of soil improving agents to the soils contaminated by lead and cadmium allows to decrease concentration of heavy metals in the yield (green mass of maize) by 1-12 times when compared with control.

Thanks to the complex improvement of soil properties and conditions as well as balanced composition of the organic soil improving agents it is possible to obtain high

ecologically clean and biologically valuable yields of agronomic cultures with an optimum content of proteins, carbohydrates, vitamins, amino acids and other health-giving substances. Thanks to the top quality yields of vegetables, fruit, berries and cereals it is possible to use soil improving agents in the production of healthy and baby foods.

On the basis of the above mentioned experiments it is possible to recommend our soil improving agents for prompt complex improvement of the soils destroyed by the catastrophic flood in Central and Eastern Europe in 1997.

The following doses and application methods are recommended.

In the case of cultures with continuous sowing (cereals, perennial grasses), soil improving agents can be applied at the dose of 40-60 t/ha by means of surface spreading and introduction into the soil by a rotor-cultivator to the depth of up to 20 cm. Locally, soil ameliorants are applied at the dose of 40-60 t/ha with introduction into rows in the case of potato, cabbage, maize and other tilled crops or into holes at the dose of 0.5-1 litre in the case of vegetables (tomatoes, aubergines, cucumbers, cabbages), water-melons, melons and gourds mixing them further with the soil at the ratio of 1:2 - 1:5.

In the case of cultivated lands the dose of a soil improving agents can be reduced by 30-50% depending on the type of the grown crop.

While planting fruit trees, forest and decorative plants the soil improving agents are introduced into the holes and mixed with the soil in the ratios that would provide necessary conditions for the growth and development of certain plant types.

Lack of odour and favourable sanitary and hygienic properties allow for the application of organic soil improving agents in the municipal green areas, parks, lawns, etc., where soil improving agents are applied at the dose of 1-5 kg/m^2 and introduced into the soil to the depth of 10-15 cm.

CONCLUSIONS

The organic soil improving agents worked out by the specialists of the Bioecochemistry and Agroecology Departments of the Institute for Problems of Natural Resources Utilisation and Ecology of the National Academy of Sciences of Belarus are suitable for complex improvement of soil fertility and allow to obtain ecological pure yields of agricultural crops even if the soil has been contaminated by heavy metals.

The new series of soil improving agents can be suggested for the improvement of the soils damaged and contaminated by the flood in Central and Eastern Europe in 1997.

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