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RESEARCH ON THE REALIZATION OF BIOCOMPOSITE ECOFERTILIZING GRANULAR MATERIALS BASED ON PEAT

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ABSTRACT

Lately, fertilizer researches focuses on reducing the negative impact of using it on the environment and consumers, and finding new, less costly fertilizer sources.The application of organo-mineral fertilizers is a better approach to sustaining soil fertility and crop yield than applying only chemical or organic fertilizers.The paper presents the results of the researches regarding the realization and characterization of granular biocomposite biofertilizers based on peat.In order to improve the fertilizer role of the peat, the used recipe contains urea as a source of nitrogen monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, sugar beet molasses as a source of organic nitrogen, potassium and vitamins, protein hydrolyzate, as the source of protein and other microelements.

INTRODUCTION

Organic farming is practiced on approx 1% of the global agricultural area, and its importance continues to grow, being perceived by many as having less negative environmental effects than conventional agriculture (K.Lorenz, R.L et al, 2016).

Lately, fertilizer researches focus on reducing the negative impact of using it on the environment and consumers, and finding new, less costly fertilizer sources. It is aimed at making more concentrated organic fertilizers, easier to apply and more stable during plant growing periods.

Organic soil fertilization reduces or even eliminates the need for agrochemicals and mineral fertilizers, the extensive use of which leads to economic and environmental imbalances. The application of organo-mineral fertilizers is a better approach to sustaining soil fertility and crop yield than applying only chemical or organic fertilizers (J. Aguilera, et al, 2012).

The requirements introduced by the environmental protection legislation (Ministry of Environment and Water Management, 2005) and the ensure of sustainable agriculture along with modern fertilization technologies have led to an increase in the diversity of organo-mineral fertilizers. According to the European Parliament Regulation on fertilizer products bearing the CE marking, an organo-mineral fertilizer is composed of one or more inorganic fertilizers and a material containing organic carbon and nutrients of exclusively biological origin (EC no. 1069/2009 and EC no. 1069/2009 and EC no. 1107/2009, Annex 1, 2016).

Organo-mineral fertilizers are the result of an optimal blend of organic and mineral substances, depending on the nutrition needs of plants, leading to nutrient-releasing products (nitrogen, phosphorus, potassium, magnesium and other microelements) that, besides supplying deficient nutrients to plants, they also have the qualities of improving soil attributes (Blaga, Gh., et al., 2008).

Due to the advantages it presents, the use of peat, as the basis and source of organic matter for fertilizing biocomposites, has gained increasing popularity lately.

Peat, due to its complex structure and chemical composition, can be used as a raw material in chemical and biochemical processes. Hence, it is possible to use it as a fertilizer in agriculture. Long time peat has only been used as a means of improving the soil structure and increasing its organic mass content. It has been found that the use of chemical compounds resulting from peat facilitates the growth and development of plants and increases the volume and quality of the crops.

Organo-mineral fertilizers offer several advantages over organic or mineral extracts, namely: they improve the plant-mineral interaction by reducing phosphorus absorption, increase the activity of rooting young plants, influence the oxidation-reduction reaction in soil (Parent. L., et al, 2003). At the same time, these products together with the methods of fertilization constitute and represent modern technologies with significant quantitative, qualitative effects, with positive economic and environmental impact.

Considering the importance and role of organo-mineral fertilizers for the growth and support of soil fertility and crop yields, this paper presents the results of the research on the realization and characterization of granular biocomposites eco-fertilizers based on peat materials, combining chemical fertilizers (N, P , K) with biostimulators such as humic acids, fulvic acids, phytohormones, etc. to ensure both the efficiency of the use of macroelements and the quantitative and qualitative increase in agricultural production.

MATERIAL AND METHOD

In order for the product to meet the requirements of the European regulations in the field and to ensure its fertilizing role, it was taken into account that, by the components added to the peat, the following nutrients are ensured: (14-18)% Nitrogen , (22-26)% P2O5, (1-3)% MgO, (0,8-2,4)% Sulf, (3-9)% Microelements [(0,5-1,5)% Zn, (0,4-1,2)% Cu, (0,6-1,8)% Fe, (1,1-3,3)% Mn, (0,3-0,9)% Co].

The manufacturing formula used was prepared in 3 variants whose composition is shown in Table 1

Table 1.

Composition of formulas used to produce granular fertilizer biocomposite material based on peat

Nr crt.	Used substance	Percentages, %		
		Version I	Version II	Version III
1	Dry peat, humidity 20%	31,44	31,44	31,80
2	Monoammoniumphosphate (MAP)	26,19	26,19	26,19
3	Urea	15,71	15,71	15,71
4	Protein hydrolyzate	20,95	18,85	18,31
5	Starch	2,10	2,10	2,10
6	Magnesium sulphate, $MgSO_4$	3,14	3,14	3,14
7	Zinc sulphate, Zn SO_4	0,08	0,08	0,08
8	Copper sulphate, $CuSO_4$	0,05	0,05	0,05
9	Iron sulphate, $FeSO_4$	0,10	0,10	0,10
10	Manganese sulphate, $MnSO_4$	0,21	0,21	0,21
11	Cobalt sulphate, $CoSO_4$	0,03	0,03	0,03
12	Molasses from sugar beet	0	2,10	2,10
13	Orthophosphoric acid, H_2PO_4	0	0	0,18

Peat is the basic raw material and the main source of organic nutrient for the fertilizer biocomposite to be achieved. Due to its composition, peat improves physical and physicochemical properties of the soil, increases water retention capacity, absorption capacity and humus content; contributes to the reduction of soil acidity and the increase of the buffering capacity, which creates a better fund for the efficiency of mineral fertilizers.

Urea, used as a source of nitrogen, is a granular fertilizer with 46% nitrogen, which which maintains long-term a neutral pH in the soil and also contributes to the release of peat humic and fulvic acids.

Monoammonium phosphate (MAP), used as a source of phosphorus and nitrogen is a mineral fertilizer in the form of granules, with 12% nitrogen, 61% phosphorus, 0% potassium, free of chlorine and other harmful elements, totally soluble, with a low pH of 4-4.5.

Molasses from sugar beet, as a source of organic nitrogen, potassium and vitamins, is a dark viscous liquid containing 0.5-2.1% nitrogen, 2-5% potassium, and other microelements with a pH of 4.9-8.5. The role of molasses is to catalyze the enzymatic biological processes that take place at the root level in the soil, with betaine, a growth factor amino acid and biotin that is a vitamin.

Protein hydrolyzate, used as a source of proteins, polypeptides and amino acids is obtained by heating in an autoclave at 135 oC and a pressure of 4 bar for 3-6 hours of a mixture of potassium hydroxide (1-3%), wool waste (10-15%) and water. The obtained hydrolyzate contains 10-13% of proteins, polypeptides and amino acids.

The starch used was corn starch manufactured by SC ROQUETTE SA Calafat, having a moisture content of 12.01% and a density of 0.561 g / cm^3.

Microelements: cobalt, zinc, copper, iron and manganese, in the form of sulphates .

Zn sulphate as colorless crystals, is frequently used as a source of soluble zinc ions and it is necessary to activate several enzymatic systems of plants.

Cu sulphate in the form of a blue crystalline salt is the source of Cu and plays a role in plant metabolism and chlorophyll formation.

Fe sulphate in the form of a green salt has a role in the synthesis of chlorophyll, carbohydrates and nitrogen assimilation.

Mn Sulphate in the form of pale pink crystals or crystalline powder, is important in nitrogen metabolism and CO_2 assimilation and is essential in the photosynthesis process.

Co sulphate in the form of red crystals, soluble in water, is essential for nitrogen fixation.

The technological process of realization the peat-based granular biofertilization biocomposite material comprises preparation of raw materials consisting of grouping and mixing them into categories: mixture of solid components, (dry peat at 20% moisture, monoammonium phosphate and starch) and mixture of liquid components (protein hydrolyzate in which urea, molasses and microelements in the form of sulphates are dissolved), supplying the extruder with the two categories of mixtures, extrusion carried out at a temperature in the range 30-100 ° C and a pressure of 60 bar, with a feed rate of 3.3 kg / h of solids and 2.2 kg / h of liquid components, granulation made in a hammer mill and drying carried out in an air recirculation oven.

The technological process used to obtain peat-based granular biofertilization biocomposite material was done using the plant shown in Figure 1.

The peristaltic pump type SP 311/6, manufactured by VELP Scientifica, for liquid dosing can achieve flows ranging from 6 to 35 ml / min.

The feeder for powdered materials, is a double-screw volumetric feeder designed to feed granulated materials between 2.0 and 40 microns at a humidity of max. 15%, with the possibility to continuously adjust the flow rate between 0.3 and 10 kg / h. The supplying will be continuous, any supplying interruption leading to variations in flow and properties of the finished product.

The extruder is the "ZK 25" type, Collin manufacturing, with two modular corotative screws with with a productivity of max. 15 kg / h, screw diameter: D = 25 mm, screw length: L = 30xD, screw speed: max. 400 rpm. The extruder cylinder is also modular and has 5 zones (Z1-Z6) removable and interchangeable with each other, each with independent heating and cooling. The extruder is provided with an ECS control microprocessor, with the possibility to adjust and maintain the temperature in the five working areas of the extruder, adapter and die. The part of the cylinder that form the area Z2 has an orifice for dosing liquid components (plasticizers).

Fig.1. The installation for realization of granular fertilizer biocomposite material based on peat

*Peristaltic pump **1**, The feeder for powdered materials 2, Extruder 3, Die 4, Cooling area **5***

The die is provided with 3 holes of 2.5 mm in diameter, with its own heating system with an installed power of 5 kW and three temperature sensors.

Cooling area ensure the decrease temperature of the product with a view to collecting and granulating it.

The grinding equipment is a hammer mill type whose rotor has a diameter of 220 mm is driven at 1000 rpm with a single-phase electric motor with a power of 500 W.

Table 2 presents the parameters of the technological process.

Table 2.

The parameters of the technological process

Parameter	U.M	Value					
Temperature in the area	^{0}C	Z1	Z2	Z3	Z4	Z5	Z6
		30	30	40	60	80	100
Flow rate of solid components	Kg/h	3,3					
Flow rate of liquid components	Kg/h	2,2					
Flow feed ratio solid / liquid	-	1,5					
Extrusion pressure	barr	60					

RESULTS AND DISCUSSIONS

Following the thermoplastic extrusion of the mixtures, according to the formulas used in the three variants,a biocomposite eco-fertilizer material was obtained, figure 2; a) before granulation, b) after granulation.

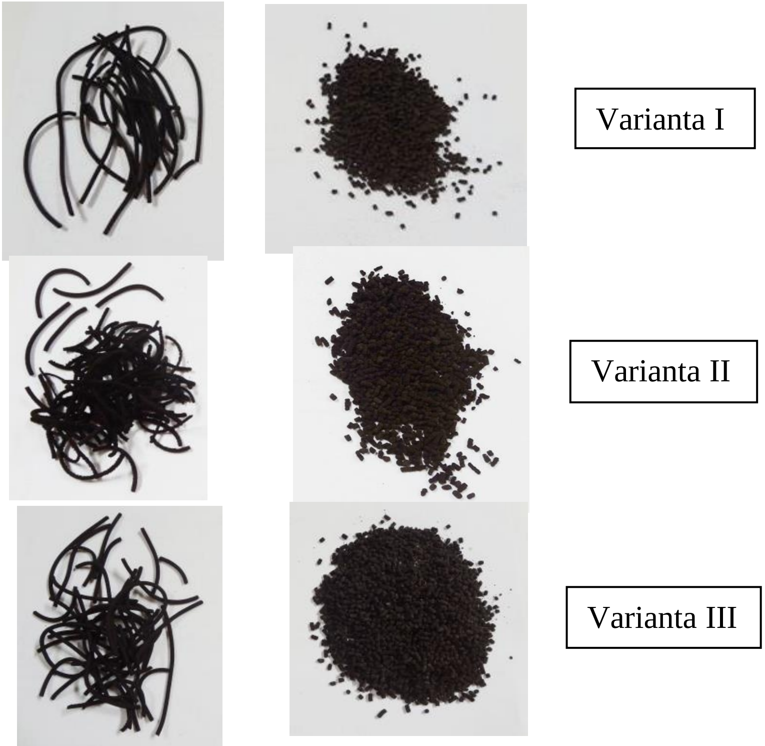

Fig. 2. Granular fertilizer biocomposite material based on peat
a)-before granulation, b)-after granulation

Table 2.
Characteristics of bio-fertilizer biocomposite material.

Characteristics	**U.M**	**Value**		
		Version I	**Version II**	**Version III**
Color		negru	negru	negru
Humidity	%	6.8	8.2	5.6
Water absorption degree	%	41	55	70
Granulation, fraction: 2-5 mm	%	75.0	51.0	80.0
1-2 mm	%	10.0	22.0	8.1
0.5-1 mm	%	2.0	4.5	2.8
0.25-0.5 mm	%	3.4	8.3	3.6
< 0,25	%	9.6	14.2	5.5
Compression strength	N	32.52	29.64	33.00
Bulk density	Kg/m^3	747	650	694
Organic carbon content	%	22.05	22.57	22.55
Carbon / Nitrogen mass ratio		12.14	12.42	12.38
pH		6.7	6.7	6.1

Table 2 lists the main characteristics of the eco-fertilizer biocomposite material. From their analysis it results that in all formula variants studied, both the organic carbon content and the C / N ratio show values to the requirements imposed for organ-mineral fertilizers . Between 75 and 80% of the product falls into the granulometric fraction 2-5 mm, except for working version II. Bulk density ranged between 850-750 kg/m^3 and compressive strength between 30 and 33 N.

CONCLUSIONS

The application of organo-mineral fertilizers is a better approach to sustaining soil fertility and crop yield than applying only chemical or organic fertilizers.

Due to the advantages it presents, the peat is a basis and source of organic matter for fertilizing biocomposites.

The production formula that underpinned the development of the peat-based granular biofertilization biocomposite material is aimed to achive an optimal blend of organic and mineral substances, depending on the nutrition needs of the plants. It contains urea, as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, sugar beet molasses as a source of organic nitrogen, potassium and vitamins, protein hydrolyzate as a source of protein, cobalt sulphate, zinc sulphate, copper sulphate, iron sulphate and manganese sulphate.

The realization of the peat-based granular biofertilization biocomposite material was made by thermo-plastic extrusion and granulation.

The characteristics of eco-fertilizing biocomposite have values corresponding to the requirements imposed for organo-mineral fertilizers.

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