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RESEARCHES ON THE REALIZATION OF A TECHNOLOGY TO OBTAIN GRANULAR ORGANO–MINERAL FERTILIZERS BASED ON PEAT

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Abstract: Lately, researches in fertilizer fields focuses on reducing the negative impact of using them on the environment and consumers, and finding new, less costly fertilizer sources. The paper presents the results of the research regarding the realization of a technology for obtaining of peat based granular organo–mineral fertilizers. In order to improve the fertilizer role of the peat, the production formula used contains urea as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, molasses from sugar beet as a source of organic nitrogen, potassium and vitamins, protein hydrolyzate, as a source of proteins, polypeptides and amino acids and other microelements
Keywords: peat, fertilizers, granule, organo–minerals

INTRODUCTION

Organic agriculture 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).

As a result, fertilizer research has recently focused on reducing the negative impact of its use 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, of which extensive use leads to economic and environmental imbalances. The combined application of organo–mineral fertilizers has proven to be a better approach to increase and sustain soil fertility and yields 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 provision 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's 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 (CE nr. 1069/2009 și CE nr. 1107/2009, Anexa 1, 2016).

Organo–mineral fertilizers are the result of an optimal blend of organic and mineral substances, depending on plant nutritional needs, which will lead to products that release nutrients (nitrogen, phosphorus, potassium, magnesium and other microelements) which, besides supplying deficient nutrients to plants, also have the qualities of improving soil attributes (Blaga, Gh. et al, 2008).

Due to its advantages, the use of peat, as the basis and source of organic matter for fertilizers, has gained increasing popularity lately. Organo–mineral fertilizers offer several advantages over organic or mineral ones taken separately, namely: they improve the plant–mineral interaction by reducing phosphorus absorption, increase the activity of rooting young plants, and 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 development of a technology for obtaining peat–based granular organo–mineral fertilizers, which involves the combination of 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 European regulations in the field (EC 1107/2009, Annex 1, 2016) and to carry out an efficient fertilization of the vegetable crops for which it is intended, it is proposed that the components added to the peat provide the following nutrients listed in Table 1.

Table 1. Value ranges of macroelements and microelements in organo–mineral fertilizer composition

	Fertilizing elements	Minimum values, %	Maximum values, %
Macronutrients	Nitrogen, N	14,0	18,0
	Phosphorus, in the form of phosphorus pentoxide, P_2O_5	22,0	26,0
	Magnesium, as Magnesium Oxide, MgO	1,0	3,0
	Sulfur, S	0,8	2,4
Micronutrients	Zinc, Zn	0,5	1,5
	Copper, Cu	0,4	1,2
	Iron, Fe	0,6	1,8
	Manganese, Mn	1,1	3,3
	Cobalt, Co	0,3	0,9

In order to improve the role of peat fertilizer, which is the basic raw material and supply with fertilizing macronutrients and micronutrients, the proposed formula will contain urea as a source of nitrogen, monoammonium phosphate (MAP) as a source of phosphorus and nitrogen, molasses sugar beet, as a source of organic nitrogen, potassium and vitamins, proteic hydrolyzate, as a source of protein, cobalt sulfate, zinc sulfate, copper sulfate, iron sulphate and manganese sulphate.

Urea also contributes to the release of humic and fulvic acids from the peat and, together with molasses, serve as binders to ensure the cohesion of the recipe components.

To determine the proportion of ingredients that bring in the formula the nutrients within the mentioned limits proceeded as follows.

Since the Monoammonium phosphate (MAP) containe 62% phosphorus pentoxide, P_2O_5 and 12% nitrogen, N, therefore, to ensure the minimum and respectively maximum phosphorus demand, the following quantities of MAP are required:

$$MAP_{min} = 22/0,62 = 35,50 \text{ kg};$$
$$MAP_{max} = 26/0,62 = 41,94 \text{ kg};$$

Nitrogen results from MAP and Urea. Since MAP contains 12% nitrogen, it results that from the amount of MAP needed for P2O5 are obtained at minimum value: 35,5 x 0,12= 4,26 kg nitrogen and at maximum value: 41,94 x 0,12= 5,04 kg nitrogen

From urea, we have the difference in nitrogen needed. Since urea has 46% nitrogen, it results:

$$Urea_{min} = (14-4,26)/0,46 = 21,17 \text{ kg};$$
$$Urea_{max} = (18-5,04)/0,46 = 28,17 \text{ kg};$$

Magnesium sulphate contains 33.3% Magnesium oxide, MgO and 26.7% Sulfur, S. It follows that the following quantities of Magnesium Sulphate are required to ensure the required minimum and maximum Magnesium Oxide:

$$MgSO_{4min} = 1/0,333 = 3 \text{ kg};$$
$$MgSO_{4max} = 3/0,333 = 9 \text{ kg};$$

These amounts of magnesium sulphate, $MgSO_4$ provide a percentage of sulfur, S:

$$S_{min} = 3 \times 0,267 = 0,8\ \%;$$
$$S_{max} = 9 \times 0,267 = 2,4\ \%;$$

Zinc sulphate contains 40% Zinc, Zn. To ensure the minimum and maximum zinc requirements, the following quantities of zinc sulphate are required:

$$ZnSO4min = 0,5/0,4 = 1,25 \text{ kg};$$
$$ZnSO4max = 1,5/0,4 = 3,75 \text{ kg};$$

Similarly, depending on the percentage content of microelements in the sulphates, the minimum and maximum quantities of sulphates are set.

Copper sulphate

$$CuSO_{4min} = 0,4/0,4 = 1,0 \text{ kg};$$
$$CuSO_{4max} = 1,2/0,4 = 3,0 \text{ kg};$$

Iron sulphate

$$FeSO_{4min} = 0,6/0,37 = 1,62 \text{ kg};$$
$$FeSO_{4max} = 1,8/0,37 = 4,86 \text{ kg};$$

Manganese sulphate

$$MnSO_{4min} = 1,1/0,36 = 3,05 \text{ kg};$$
$$MnSO_{4max} = 3,3/0,36 = 9,15 \text{ kg};$$

Cobalt sulphate

$$CoSO_{4min} = 0,3/0,36 = 0,83 \text{ kg};$$
$$CoSO_{4max} = 0,9/0,36 = 2,50 \text{ kg};$$

It results the total mass of the components without peat:

$$M_{min} = 67,95 \text{ kg};\ M_{max} = 102,37 \text{ kg};$$

Taking into account the composition of the formula and the mass of the other ingredients making up, for the use of a a percentage (25–30%) of dry peat results in a quantity of dry peat (MTU) of:

$$MTU_{min} = 0,3/0,7 \times M_{min} = 29,12 \text{ kg};$$
$$MTU_{max} = 0,30/0,7 \times M_{max} = 43,87 \text{ kg};$$

RESULTS

The calculations made with the purpose of providing fertilized macro and microelements have led to the establishment of the formula components underlying the development of the technology for obtaining peat–based granular organo–mineral fertilizers. Thus, the percentage of components is between the following limits:

- (25–30)% peat with humidity of 30%,
- (30–40)% monoammonium phosphate MAP,
- (2.5–7.5)% Magnesium sulphate MgSO4,
- (20–25)% Urea,
- (2–10)% Molasses containing 0.5–2.1% nitrogen and 2–5% potassium,
- (2–5)% Protein hydrolyzate containing 10–15% amino acids,
- (1,2–3,6)% zinc sulphate ZnSO4,
- (0.7–2.1)% CuSO4,
- (1.5–4.5)% FeSO4,
- (3–9)% manganese sulfate MnSO4,
- (0.9–2)% cobalt sulfate CoSO4.

Figure 1 shows the diagram of technological process to obtain granular organo–mineral fertilizers based on peat.

The technological process comprises the following phases:

— Preparation of raw materials

Preparation of raw materials consists of grouping and mixing them into categories:

- mixture of solid components, consisting of dry peat at 30% moisture, monoammonium phosphate (MAP) and starch. The mixture thus formed was milled in the hammer mill, using a 3.5 mm sieve, at a rotor speed of 3000 rpm, thus rendering the texture and granulation corresponding to the feed of the extruder through the pulverulent dispenser.
- mixture of liquid components consisting of the protein hydrolyzate in which urea, molasses and microelements in the form of sulphates are dissolved.

— Supplying the extruder

Supplying the extruder with the two categories of mixtures is done through the two feed points, dosing the mixture of solid components in the extruder funnel with a two screw feeder and dosing the liquid mixture with a peristaltic pump.

The supplying is continuous, any supplying interruption resulting in variations in the flow and properties of the finished product.

Supplying rates are set so as to meet the proportions according to the formula that ensure the needed nutrient in the granules, to be possible to process the blends in the extruder and the product obtained has the characteristics necessary for it to be manipulated and applied in the field.

The ratio of the two feed rates determines among others the amount of binder in the final product, with great influence on its quality.

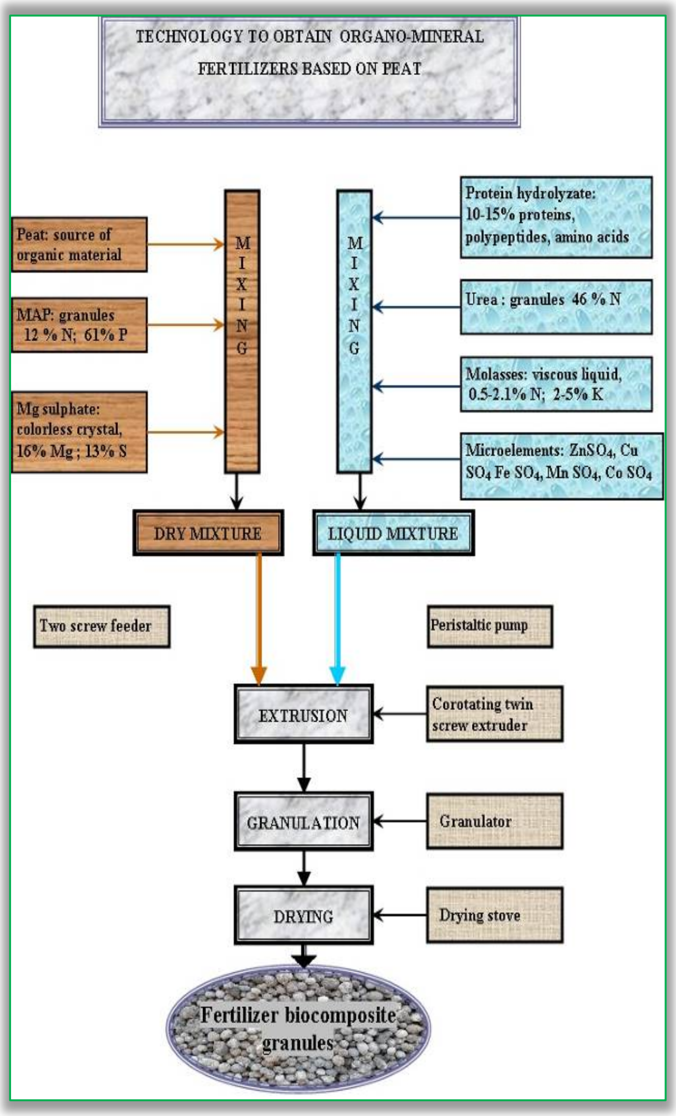

Figure1 – Diagram of technological process for obtaining granular organo–mineral fertilizers based on peat.

— Extrusion

Mixtures dosed through the two feed points of the extruder, Figure 2, are taken up by the two co–rotative screws which homogenize and process them by shearing and heating while being moved to the die. On the other hand, due to the rotation of the screws, there is an increase in pressure to the die.

Figure 2 – Extrusion plant type „ZK 25", production Collin

The temperature of the cylinders is pressed and maintained at the values set by the cylinder heating and cooling system. The speed of the screws is adjustable, allowing the material to pass through the extruder.

When passing through the die, the material must have the temperature and pressure required to obtain a finished quality product.

In order to preserve the properties of the components in the formula, especially of the peat, the temperature and pressure regime in the extruder must be moderate.

Table 2. The parameters of the extrusion process

Parameter	units	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					
Solid/liquid feed flow ratio	–	1,5					
Extrusion pressure	barr	60					

— Granulation

Granulation has the purpose of ensuring the flow properties of the finished product and is carried out in a hammer mill whose 220 mm diameter rotor is driven at 1000 rpm with a single–phase electric motor having the power of 500 W.

— Drying

Drying aims to reduce the humidity of the granules and improve their mechanical properties and is carried out in an air recirculation oven and placing the granules on a sieve in a single layer, with the possibility of bringing the hot air to the entire surface of the granules. The drying temperature is 40–60 °C.

CONCLUSIONS

The application of organo–mineral fertilizers is a better approach to sustain soil fertility and crop yield than applying only chemical or organic fertilizers. Due to the advantages it presents, peat is a basis and source of organic matter for fertilizing biocomposites.

The manufacturing formula that underpinned the development of the technology to obtain granular organo–mineral fertilizers based on peat aims to achieve an optimal blend of organic and mineral substances, depending on the nutrition needs of 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.

Obtaining the organo–mineral fertilizers according to the developed technology is achievable by thermo–plastic extrusion and granulation.

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