

HUMIC FERTILIZERS – FERTILIZING SUBSTANCES OF HIGH EFFICIENCY IN AMELIORATION OF PLANT NUTRITION IN SUSTAINABLE AGRICULTURE

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Abstract

Relatively low cost and relatively high content of humic acids in low grade coals (brown coal, lignite, leornadite, peat) fully justify their use to for productions of organo-mineral (humic) fertilizers which have been largely developed in the last time. In some contries (USA, Japan, China, Israel, Spain, Russia) there are numerous factories producing humic fertilizers at an industrial level having in their composition associations of humic acids with nutrients in a form of mineral compounds.

In Romania, the research to produce organo-mineral fertilizers has been started since more two decades ago. At present, there are 6 types of humic fertilizers on lignite support which can produse, in a pilot installation more than 7000 t fertilizers per year, put into operation in 2008, built at Tg. Jiu by the National Research-Development Institute for Soil Science, Agrochemistry and Environmental Protection Bucharest, in cooperation with National Lignite Society, Oltenia, Tg Jiu, within the framework of the project No. 1183 Relansin, 2003-2005.

This paper presents the properties of some fertilizers, their high effects as fertilizers as compared to the classical ones, on the plant nutrition, soil fertility amelioration in time and significant migration of soil chemical pollution.

INTRODUCTION

The obtained knowledge on the properties of humic acids and their importance in defining the multiple proprieties of soil led to the idea to use the low-grade coals (brown coal, lignite, to leonardite, peat) which contain high amounts of humic acids as organic (humic) fertilizers.

Organo-mineral fertilizers on lignite support include in their composition humic acids associated with different mineral salts.

The research to produce organo-mineral fertilizers on lignite support in relative new in Romania. This research started 2.5 decades ago (Dorneanu et al., 1971; Rogoz et al, 1972) and it was continued till now within the framework of some interdisciplinay programes operated by:

- National Research-Development Institute for Soil Science, Agrochemistry and Environmental Protection, Bucharest;
- Chemical Enterprise, Craiova Industrial Central for Chemical Fertilizers, respectively;
- Research Development Center, Dăbuleni Research Station for Plant Growing on Sands, respectively.

On the basis of positive results obtained in conception of organo-mineral fertilizers on lignite support, in 2000, the Research Development Institute of Soil Science, Agrochemistry and Environmental Protection - ICPA, Bucharest, together with the National Lignite Society, Oltenia, Tg. Jiu, as cofinancing, managed to contract the project Nr. 1183/2001-2003 within the RELANSIN research program that permitted to carry out a pilot installation to produce organo-mineral fertilizers on lignite support with a capacity of 7000 t per year.

At the same time with the starting of this installation function, at present being in the final (and modernization) stage, a real base has been created to extend the production of fertilizers on lignite support in Romania (Dorneanu et al, 2008).

The opportunity to obtain the organo-mineral fertilizers from lignite in Romania due to the important lignite reserves in Romania, in the large missing exploitations of Oltenia, with organic matter (OM) content of 60.54-69.52%; humic acids SiO₂ 14.98-39.46% (AH); 24.94-38.62% (Dorneanu Emilia et al., 2002; Davidoiu et al., 2008).

MATERIAL AND METHODS

The organo-mineral fertilizers obtained by technological mixture of lignite with some minerals salts have been comparatively tested with classical chemical fertilizers applied at equivalent amounts to the corn fertilization.

Testing has been rigorously carried out in field on Psammosols (sandy soils) and Albic (podzolic) luvisols, both soils having a low humus content.

Two categories of fertilizers have been tested:

- organo-mineral fertilizers on pelletized lignite support in successive layers with a urea solution;
- organo-mineral fertilizers on pelletized lignite support in successive layers with humic acids extracted from lignite as the potassium humates.

RESULTS AND DISCUSSION

The first category is represented by the L-200 and L-300 fertilizers with humic acids and nitrogen and by the Super H-210 complex fertilizers, Super H-120, respectively, with humic acids and phosphorus at different rations. All these pelletized fertilizers with urea solution have lower contents of humic acids, between 10 and 22% (table 1).

The second category is represented by the L-200 hum, L-300 hum and by the Super H-210 hum complex fertilizers, Super H-120 hum, respectively.

Table 1

Composition and properties of pelletized organo-mineral fertilizers on lignite support, pelletized in successive layers with a urea solution, prepared in the installation from SNLO, Tg. Jiu and homologated for use in Romania's agriculture

No.	Item	MU	L-200	L-300	Super H-210	Super H-120
1	Composition					
1,1	Humic acids	%	16.0	10.0	17.0	22.7
1,2	Nitrogen (N)	%	22.0	28.0	20.55	9.15
1,3	Phosphorus (P ₂ O ₅)	%	-	-	9.75	16.50
1,4	Potassium (K ₂ O)	%	0.255	0.197	0.226	0.307
2	Properties					
2,1	Cation exchange capacity	me/100 g	48.0	35.8	41.0	55.7
2,2	Bulk density	g/cm ³	0.738	0.707	0.720	0.813
2,3	Granulation (1-5 mm)	%	82.0	86.0	79.3	88.6

These palletized fertilizers with potassium humates have higher contents of humic acids, between 24.3 and 29.9% higher nitrogen contents and a supplement of potassium included in humates (table 2).

Table 2

Composition and properties of new pelletized organo-mineral fertilizers on lignite support, pelletized in successive layers with potassium humates in a micropilot, which is going to be homologated and follow to be produced in the modernized installation from SNLO, Tg. Jiu

No.	Item	MU	L-200 Hum	L-300 Hum	Super H-210 Hum	Super H-120
1	Composition					
1,1	Humic acids	%	29.9	24.3	28.5	26.4
1,2	Nitrogen (N)	%	23.49	29.21	21.97	10.47
1,3	Phosphorus (P ₂ O ₅)	%	-	-	9.75	16.50
1,4	Potassium (K ₂ O)	%	2.80	2.80	2.80	2.80
2	Properties					
2,1	Cation exchange	me/100 g	96.3	75.2	70.3	83.9

	capacity					
2,2	Bulk density	g/cm ³	0.823	0.782	0.801	0.852
2,3	Granulation (1-5 mm)	%	89.9	92.3	88.9	93.5

Table 3 shows the average yields obtained with the fertilizers in the first category applied to corn grown on irrigated psammosols for five years.

As compared to the control (M₂) fertilized with chemical fertilizers, the treatments with L-200, L-300, Super H-210 and Super H-120 organo-mineral fertilizers led to yield increases with 15.9-20.8%.

Table 3

Yield increases obtained with palletized organo-mineral fertilizers with a urea solution applied to corn HF-420 grown on irrigated Psammosols (sandy soil) at the Research - Development National Center for Plant Growing on Sands, Däbuleni - Dolj

No.	Treatments	Average yield kernels (5 years) kg/ha	Yield increase			
			kg/ha	% as compared to		kg kernels/ kg fertilizer (N-P ₂ O ₅ - K ₂ O)
				M ₁	M ₂	
1	Control (M ₁)	2808	-	100.0	-	-
2	Urea, TSP*, Potash salt (M ₂)	5290	2482	188.4	100.0	6.2
3	L-200, TSP* Potash salt	6210	3402	221.1	117.4	8.5
4	L-300, TSP* Potash salt	6136	3328	218.5	115.9	8.32
5	SH-210 Potash salt	6353	3545	226.2	120.0	8.86
6	SH-120, Urea Potash salt	6359	3587	227.7	120.8	8.96

LSD 5% 620

1% 900

0.1% 1180

*TSP triple superphosphate

Fertilization rate: N-200; P₂O₅-100; K₂O-100 kg/ha

Table 4 shows the average yields obtained for 2 years with pelletized with humates. Their efficiency has been compared with the pelletized fertilizers with a urea solution, both been applied at a rate of 500 kg/ha physical products. The yield increases recorded in the treatments with pelletized fertilizers with humates are significantly higher than those obtained in the treatments with palletized fertilizers

with a urea solution and correlate with the increase of humates included in the respective fertilizers.

The tests carried out with corn and other crops (potatoes, sunflower) proved higher efficiency of organo-mineral fertilizers on lignite support, which improves plant nutrition by ensuring easily assimilable forms of contained nutrients on way of both solubility and continuous changing of ions adsorbed in humates with other-ions in soil solution, as well as the formation of humic chellates which action as active physiological substances with effect of stimulating the germination and vegetative growing of plants (Dorneanu et al., 2008; Kashl et al., 2005). Concomitant these fertilizers improve some qualitative properties of soil by increasing the content of humates, such as cation exchange capacity increase, microstructure fermentation, long term water holding capacity increase, biological activity stimulation (Dorneanu et al., 2008; Kline's, 1994).

Table 4

Yield increases obtained with palletized organo-mineral fertilizers with potassium humates applied to corn HS Talman, grown on Albic (podzolic) Luvisols at the Horticultural Research - Development Station, Tg. Jiu

Fertilizers type	Applied physical substances kg/ha	of which:		Total a.i. kg/ha	Kernel production kg/ha	Yield increase		
		NPK kg/ha	Humic acids kg/ha			kg/ha	%	kg kernels/kg a.i.
Nefertilizat	-	-	-	-	1260	-	100.0	-
L-200	500	NK-111.3	80.0	191.3	3210	1950	254.8	10.19
L-200 hum	500	NK-131.5	149.5	281.0	3700	2440	293.6	8.61
SH-120	500	NPK-129.8	113.5	243.3	4280	3020	339.7	12.41
SH-120 hum	500	NPK-148.9	132.0	290.0	4450	3190	353.2	11.00

DL 5% 430
 1% 610
 0.1% 820

On the basis of the tests carried out, it is estimated that, for the first stage, in Romania, a minimum of over 800000 t/year of organo-mineral fertilizers on lignite support is necessary for fertilization of 1.1 million hectares (Dorneanu et al., 2008).

CONCLUSIONS

1. On the basis of presented data, it may be estimated that the organo-mineral fertilizers on lignite support, due to their content in humates, have a series of specific properties that impart them higher fertilization qualities as compared to the classical chemical fertilizers.
2. Incorporation into a organo-mineral matrix with humates ensures the assimilation of nutrients at a higher proportion than by applying chemical fertilizers, and the soil chemical pollution degree is significantly reduced.
3. Use of fertilizers on lignite support presents the advantages that they can economic efficient use, under higher conditions a significant part of the more than 4 miliard tones of coals with humic acids existent in Romania and they can ensure a humic fertilization of an important land area of the more than 7 million ha of humus deficient soils.
4. An essential economic advantage of production of organo-mineral fertilizers on lignite support is represented by the lower energy consumption and production costs, having in view the contribution of active ingredient in coal which are less than costs of the chemical fertilizers with 22-25%.

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