Ingenious Eco-Technology for Transforming Food and Tanneries Waste into a Soil Bio-Conditioner and Fertilizer Product Used for Recovery and Enhancement of the Productive Capacity of the Soil

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***Abstract*—**The present work deals with the way in which food and tobacco waste can be used in agriculture. As a result of the lack of efficient technologies for their recycling, we are currently faced with the appearance of appreciable quantities of residual organic residues that find their use only very rarely and only after long storage in landfills. The main disadvantages of long storage of organic waste are the unpleasant smell, the high content of pathogenic agents, and the high content in the water. The release of these enormous amounts imperatively demands the finding of solutions to ensure the avoidance of environmental pollution. The measure practiced by us and presented in this paper consists of the processing of this waste in special installations, testing in pilot experimental perimeters, and later administration on agricultural lands without harming the quality of the soil, agricultural crops, and the environment. The current crisis of raw materials and energy also raises special problems in the field of organic waste valorization, an activity that takes place with low energy consumption. At the same time, their composition recommends them as useful secondary sources in agriculture. The transformation of food scraps and other residues concentrated organics thus acquires a new orientation, in which these materials are seen as important secondary resources. The utilization of food and tobacco waste in agriculture is also stimulated by the increasing lack of chemical fertilizers and the continuous increase in their price, under the conditions that the soil requires increased amounts of fertilizers in order to obtain high, stable, and profitable production. The need to maintain and increase the humus content of the soil is also taken into account, as an essential factor of its fertility, as a source and reserve of nutrients and microelements, as an important factor in increasing the buffering capacity of the soil, and the more reserved use of chemical fertilizers, improving the structure and permeability for water with positive effects on the quality of agricultural works and preventing the excess and/or deficit of moisture in the soil.

***Keywords*—**Organic residue, food and tannery waste, fertilizer, soil.

I. Introduction

ORGANIC products of various types are recognized as true sources of nutrients with beneficial effects on soil and plant production. Biocomposts that have as their component organic residues from the food industry and from tobacconists, unlike zootechnical waste, pose a series of problems, on the one hand due to the origin, and on the other hand, the content of some harmful elements above the maximum admissible limit.

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The use of biocompost from food and tannery waste in vegetable crops, on the land in greenhouses and solariums, but also in the field, where large quantities of organic fertilizers are needed, could be a practical and economic alternative. However, this is requiring in-depth and long-term studies, especially in order to prevent and combat environmental pollution, but also to establish the consequences on plant production.

In this research phase, we experienced how the moderate dose of biocompost acts on some physical and chemical properties (organic matter, pH, N, P, K) of the soil, without affecting the quality of plant production. It is important to follow the translocation of nutrients and potentially polluting elements in the soil and from there in the plant, in the edible tissues for human consumption and in the vegetable layer used in animal feed. The researches are organized in experimental pilot perimeters, in the 3rd year of experimentation [5]-[7].

II. Research Method

The experiments follow the residual effect (third year) of biocompost doses on two types of soil located on different slopes. For the experiment, the equivalent doses of: 0, 5, 10, 20, 30,40 tons/hectare, respectively 0, 5, 10, 20, 30,40 kg/plot of 10 square meters were administered [1]-[4]. The experimental crops were sugar beet and grain corn. The research was carried out on control plots of 10 m.p. The studied factors and their degrees are:

– The slope gradient:
- Alluvial clay soil with a slope of 10%
- Alluvial clay soil with a 20% slope

– The dose of biocompost:
- 0, 5, 10, 20, 30, 40 Kg/plot

The experiment included three repetitions, being of the type 2 x 6 x 3 = 36. Biocompost was used, combined with plant residues. Corresponding to each plot there are collection channels for the strict control of rain or irrigation water runoff [1]-[4]. The following determinations were made:

- At soil level
- Physical analysis:
* granulometric composition

∗ structural hydrostability
∗ permeability
∗ penetration resistance
∗ apparent density
∗ total porosity
∗ suction.
• Chemical analysis:
∗ organic matter content;
∗ total nitrogen content (Nt);
∗ mobile phosphorus (Pm);
∗ content of exchangeable cations.
- At plant level
• content of N, P, K, Na, Ca, Mg;
• content of heavy metals (Cu, Zn, Pb, Co, Ni, Mn, Cr, Cd);
• vegetable mass (leaves and roots).

III. Results Obtained

The main results obtained regarding the soil and the plant are the following:

A. Quantitative Effects

Production (roots and leaves) in the 3rd year of experimentation showed an increasing trend compared to the untreated control. This varied between 4.8 and 12.7 kg/plot green substance. Maximum values were recorded in the case of the variant with 10 kg/plot, the increase in the dose of biocompost causing significant increases in production.

Referring only to the main production, the best results were also presented by the version with 10 kg/plot of biocompost, 11.1 kg/plot compared to the control which recorded 3.7 kg/plot.

The slope of the slope led to statistically insignificant changes in the plant mass. The maximum values were presented by the mixture with 10 kg of biocompost/plot both at the 10% slope (12.8 kg/plot) and at the 20% slope (13.7 kg/plot).

Biocompost dosage	Production	
(Kg/lot)	Full plant	Root
	(Kg/plot)	(Kg/plot)
0	4,8	3,7
5	12,5	10,8
10	12,7	11,1
20	10,5	8,9
30	10,1	8,4
40	9,7	7,9
TEST FISHER	**	**
STUDENT- DL5%	34	33

Fig. 1 The effect of biocompost doses on plant mass in sugar beet

The results obtained reveal the fact that the incorporation of doses of biocompost into the soil causes significant increases in production. The variant in which the dose of 10 kg/plot of biocompost was applied recorded maximum values, so this can be considered optimal for use on agricultural land. At the same time, the production recorded in the variants with a slope of 10% is higher compared to those with a slope of 20%, something obvious taking into account the fact that at the base of the slope the soil is more fertile than in its upper third.

Slope degree	Biocompost dosage	Production (Kg/plot)	
	(Kg/plot)	Full plant	Cobs
10%	0	6,3	4,9
	5	12.7	10.9
	10	13,7	10,9
	20	11,3	9,2
	30	10,7	8,9
	40	11,6	9,6
20%	0	3,4	2,5
	5	12,2	10,8
	10	12,8	11,3
	20	9,8	8,5
	30	9,5	8,0
	40	7,9	6,2
TEST FISHER		ns	ns
STUDENT- DL5%		48	46
TUKEY - W5%		84	81

Fig. 2 The effect of biocompost doses on corn production

B. Qualitative Effects

Effects on the Physical Characteristics

Granulometric composition: Following the introduction of a material with a different granulometric composition into the soil, changes occur in this characteristic, considered to be very stable in relation to natural and anthropogenic factors. Thus, the contents of coarse sand and fine sand increase in relation to the applied dose, since the biocompost also contains sand, for better homogenization. In the case of variants with a 10% slope, a slight textural change is observed from a soil with fine (medium clay loam) to a medium textured soil (medium clay). This has a positive effect on soil workability and specific plowing resistance. On the slope with a slope of 20%, by applying the six doses of biocompost, the soil does not undergo changes in the granulometric composition, it keeps the same textural subclass, of medium clay, due to erosion processes and runoff on the slope.

Effects on Some Agrochemical Properties in the Soil

The application of doses of biocompost caused changes in some agrochemical properties of the soil. The reaction of the given soil changed, so that: on the 10% slope the pH dropped from 7.10 to 6.60. This phenomenon is possible due to the buffering capacity of calcium and magnesium cations. In the case of the 20% slope, the pH, as expected, increased as the doses of biocompost applied to the soil increased, causing the soil reaction to change, i.e. the transition from an acid soil to a slightly acid soil. The content of organic matter also increased with the increase in the doses of biocompost applied, the accumulation of this product in the soil being stronger in the case of the 10% slope. The enrichment of soils in organic matter contributed to the improvement of the content of N, P, K in the soil, which increased with the dose of biocompost applied.

Slope	Biocompost dosage	Granulometric composition					Texture clas
		Rough sand	Sand	Dust	Colloid clay	Physical clay	
		2-0,2	0,2-0,02	0,02-0,002	<0,02	<0,01	
	(Kg/plot)	(mm)					
10%	0	11,3	31,5	31,1	26,1	41,1	LL
	5	10,4	34,0	29,8	25,8	41,1	LL
	10	10,8	34,4	29,4	25,4	39,3	LL
	20	11,5	34,9	27,6	25,0	40,4	LL
	30	10,1	36,9	27,6	25,4	40,5	LL
	40	11,4	37,0	27,1	24,5	39,3	LL
20%	0	0,0	34,7	31,6	33,7	48,3	TT
	5	1,5	35,4	30,0	33,1	48,0	TT
	10	2,0	36,9	29,1	32,0	47,5	TT
	20	2,8	37,2	28,6	31,4	45,9	LL
	30	4,8	38,3	28,2	28,7	43,1	LL
	40	5,3	39,2	27,5	28,0	43,5	LL
TEST FISHER		**	ns	ns	**	ns	
STUDENT- DL5%		1,77	2,96	1,75	1,49	2,63	
TUKEY - W5%		3,10	5,18	3,07	2,61	4,60	

Fig. 3 The granulometric composition of the soil in the experimental perimeter

As a result of the incorporation of excessive doses of biocompost into the soil, the content changes in exchangeable cations. The content of divalent calcium and magnesium cations increases significantly with the applied dose. The concentration of monovalent sodium and potassium ions also undergoes some positive changes. At the same time, the cationic exchange process is oriented towards the replacement of H+ ions, so that their concentration decreases. This determines to a large extent the modification of the plant's accessibility of the nutritional elements. The total cationic exchange capacity (T), as well as the sum of basic cations (SB) and the degree of saturation in bases (V%) increase with the dose of biocompost applied. These results highlight the good amendment role of biocompost, due to the content rich in Ca++ and Mg++ cations. [8]-[11].

Slope	Biocompost dosage (Kg/plot)	M.O. (% g/g)	pH H2O	Nt (% g/g)	P (ppm)	K (ppm)
10%	0	1,75	7,10	0,24	46	167
	5	2,45	7,04	0,34	178	170
	10	2,61	7,01	0,35	293	197
	20	3,82	6,59	0,42	601	302
	30	5,38	6,71	0,63	789	603
	40	6,05	6,60	0,69	912	802
20%	0	1,08	6,08	0,21	35	53
	5	1.53	6.28	0.25	128	93
	10	1,92	6,43	0,27	254	133
	20	2,95	6,39	0,35	334	272
	30	3,78	6,67	0,50	483	458
	40	4,45	6,67	0,66	573	663
TEST		**	**	**	**	*
STUDENT-		0,43	0,40	0,04	141	57
TUKEY - W5%		0,75	0,71	0,07	246	101

Fig. 4 The effect of biocompost doses on the main agrochemical properties of the soil

IV. CONCLUSIONS

The use of biocompost, which consists of food scraps and tobacconist waste processed in special installations, in pilot experimental perimeters, highlighted the following:

A. At Soil Level

1. The physical properties on the two slope categories change in a positive sense. The beneficial effect of processed organic products incorporated into the soil in moderate doses is unanimously accepted. The granulometric composition on the soil with a 20% slope was significantly changed following the application of biocompost doses. In both types of soil, the structural stability of the aggregates increased.
2. The incorporation of such products on soils susceptible to various physical degradation processes, or already degraded by destructuring, compaction, etc., contributes to the amelioration and improvement of negative physical characteristics and thus to increasing soil productivity.
3. Also the agrochemical properties regarding acidity, content of organic matter and nutritional elements are modified following the application of the treatments.
4. The concentration of exchangeable cations is significantly modified, being oriented in the direction of replacing H^+ ions with bivalent Ca^{++} and Mg^{++} cations.

B. At Plant Level

1. Secondary and main production increases significantly at the dose of 10 kg/biocompost plot, and then registers a decreasing trend.
2. The contents of macronutrients in both roots and leaves increase with the dose of biocompost, the variants with 20 kg/plot being optimal from this point of view.

Compared to the results obtained, we can appreciate that the biocompost obtained from food scraps and tobacco waste processed in special installations has beneficial effects on the soil and the plant and can be used on agricultural land under the conditions of permanent monitoring.

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