UTILIZATION OF ORGANIC FERTILIZERS ON ERODED SOILS FROM THE REPUBLIC OF MOLDOVA

UTILIZAREA ÎNGRĂŞĂMINTELOR ORGANICE PE SOLURILE ERODATE DIN REPUBLICA MOLDOVA

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Abstract. *Chernozem soils with high fertility prevail in the Republic of Moldova. Yet, 500.000 hectares are exposed to erosion of high and moderate degree, a fact which decreases their fertility and the economic potential by 30-60% compared to non-eroded soils. Measures to improve soils affected by erosion by means of organic fertilizers are suggested in the present paper. The application of organic fertilizers impacts on soil fertility and the increase of crop yields.*
Key words: organic fertilizers, eroded soils, erosion, fertility

Rezumat. *În Republica Moldova predomină cernoziomuri cu o fertilitate ridicată. Din ele 500 mii hectare sunt supuse proceselor de eroziune de grad moderat şi puternic, ce contribuie la reducerea fertilităţii şi a potenţialului economic cu 30-60 % în comparaţie cu solurile neerodate. În prezenta lucrare se propun procedee de regenerare a solurilor afectate de eroziune prin antrenarea îngrăşămintelor organice. Aplicarea acestora determină creşterea fertilităţii solului şi majorarea recoltei culturilor agricole.*
Cuvinte cheie: îngrăşăminte organice, soluri erodate, eroziune, fertilitatea

INTRODUCTION

Soil erosion represents one of the main causes of immense agricultural areas degradation. It has been estimated that over 76 milliard tons of fertile soil are annually being lost through erosion at world level (Savu, 1992). In the Republic of Moldova this type of loss constitutes about 26 million tons (19 t/ha) (Complex program for the recovery of deteriorated lands and soil fertility increase, 2004). To combat soil erosion has special significance for the agriculture and the country's economy in general. Soil regeneration affected by erosion is possible through the rational use of organic fertilizers on a well-set anti-erosion background. They have a multilateral and complex impact due to the contents of organic matter, which serves to restore the humus and all necessary elements for plant nutrition.

The organic fertilizers are composed of various residual materials derived from animal farming, plant production, and the processing industry of agricultural raw materials. In the conditions of our country, the greatest part of these fertilizers comes from the livestock sector, which is the most important

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provider of organic fertilizers (bovine, porcine, ovine, caprine, caballine and poultry droppings).

A second important source is formed of agricultural plant residues (straw, corn stalks, sunflower sticks, horticulture and vine wastes, leaves, green fertilizers etc.). The composts made of different organic wastes mentioned above are of no less importance. All these residues originate from agriculture, from soil. In order to maintain a benefic biological circuit between the human and natural activity, the organic wastes should be returned to the earth. Otherwise, these materials will pollute the environment.

The aim of the research is to restore the fertility of eroded arable soils through the application of organic fertilizers. In order to meet the planned goal, the following objectives have been set: to determine the changes in the contents of total humus, of mobile phosphorus and changeable potassium in the soil; to estimate the impact of organic fertilizers on the agro-physical indicators; to determine the yield of crops depending on the doses of applied fertilizers.

MATERIAL AND METHOD

The research was carried out in the period 1996-2006 at the experimental station of pedology and erosion of the Institute of Pedology, Agrochemistry and Soil Protection named after „Nicolae Dimo" situated in the village Lebedenco, Cahul district. The experimental field is a slope of 5-7º with a north-east inclination. The study object is moderately eroded common chernozem possessing a clay texture and the content of humus of 2.07 – 2.54 %, mobile phosphorus1.54 – 1.93 mg/100 g soil, changeable potassium 15.3 – 1.8 mg/100 g soil and a weak alkaline reaction (pH 7.5 – 7.8).

The experiment was carried out in three phases. The surface of the plot is 6 m x 40 m = 240 m². The parcels are placed in a single row across the slope. The long sides of the slope are oriented along the slope.

Variants were designed to determine the optimal dose and frequency of the applied manure. Two annual doses are being tested (12.5 and 25.0 t/ha). The first is regarded as optimal dose for the preservation of humus, the second – is planned as a dose for the increase of soil fertility.

The possibility of regenerating the soil fertility through straw application variant and of specially made manure compost 80% plus alluvial soil 20% variant was also studied within the experiment. Straw is an important source of organic matter for the soil and can be used as organic fertilizer without a preliminary composting or transformation into manure (Lixandru, 2006; Rusu, 2009). The straw was incorporated into the soil with the addition of nitrogen fertilizers (10 kg N/t straw) in order to reduce the C:N proportion, after which the plots were disked and ploughed.

RESULTS AND DISCUSSIONS

The carried out research has demonstrated that organic fertilization with manure contributed to the improvement of the state of soil provision with humus, mobile phosphorus and changeable potassium (table 1).

In the second year of impact, the humus contents was of 2.07 – 2.54% in the variants, before the application of fertilizers. The highest increase was

observed on the variants in which 150 t/ha and 200 t/ha of manure was administered. In the sixth and eighth years of impact, and the increase of humus contents on the fertilized variants was respectively the following: 3.07 and 2.89%; the increases consists: 0.63 and 0.72%. Simultaneously, the increase of mobile phosphorus in comparison with the initial one increased respectively in the tenth year of impact by 1.44 – 2.03 mg/100 g soil on the variant fertilized with manure in different doses and periods. The changeable potassium values increased in the tenth year of impact by 2.9 -8.3 mg/100 g soil.

Table 1

Impact of manure on the contents of total humus, mobile phosphorus and changeable potassium in the 0-20 cm of moderately eroded common chernozem

Fertilized variant	total humus		mobile phosphorus		changeable potassium	
	%		mg/100 g soil			
	contents	increase	contents	increase	contents	increase
1996, before the incorporation of fertilizers						
Unfertilized control	2.07	-	1.89	-	16.7	-*
Manure, 50 t/ha once in 2 years	2.09	-	1.54	-	16.1	-
Manure, 100 t/ha once in 4 years	2.54	-	1.80	-	16.5	-
Manure 150 t/ha once in 6 years	2.44	-	1.85	-	17.8	--
Manure, 200 t/ha once in 8 years	2.17	-	1.78	-	16.8	-
2006, the tenth year of impact						
Unfertilized control	2.11	0.04	2.04	0.15	16.8	0.13
Manure, 50 t/ha once in 2 years	2.56	0.47	3.27	1.73	19.0	2.9
Manure, 100 t/ha once in 4 years	2.95	0.41	3.34	1.54	21.3	4.8
Manure, 150 t/ha once in 6 years	3.07	0.63	3.88	2.03	24.3	6.5
Manure, 200 t/ha once in 8 years	2.89	0.72	3.22	1.44	25.1	8.3

The application of manure in quantities of 50-100 t/ha led to the reduction of clod fractions (>10 mm) by 22.9 - 25.5 % increasing simultaneously the structural formations with the diameter under 0.25 mm by 9.6 – 14.8 % (table 2).

Table 2

Modification of moderately eroded common chernozem structure under the impact of manure in the 0 – 20 cm layer (2007)

Fertilized variant	Structural elements contents (%) with the diameter (mm)				Quality of structure (dry sieving)	Hydro-stability (humid sieving)
	>10	<0.25	∑ 10-0.25	>10+<0.25		
Unfertilized control	49.5 / -	3.6 / 72.5	47.0 / 27.5	53.1 / 72.5	average	low
Manure, 50 t/ha once in 4 years	22.9 / -	14.8 / 71.6	62.3 / 28.4	37.7 / 71.6	good	low
Manure, 100 t/ha once in 4 years	25.5 / -	9.6 / 71.0	62.9 / 29.0	37.1 / 71.0	good	low

Numerator *– total contents of aggregates (dry sieving)*
Denominator *– contents of hydro-stable aggregates (humid sieving)*

Fertilization with manure of moderately eroded chernozem contributes to the formation of structural elements that have agronomic value. So, if the sum of fractions within 10 – 0.25 mm constitutes 47% in the control variant, in the variants treated with manure the latter increased by about 16% (table 2).

Both the content of fine clay and that of physical clay is constant in all the variants treated with manure. The dusty clay-argillaceous texture can be evaluated as extremely favorable, due to the fact that it provides normal conditions for the growing of culture plants. The clay-argyles soils are treated easily when having physical maturity humidity (table 3).

Table 3

Impact of manure on the physical indicators of moderately eroded ordinary chernozem in the ploughed layer

Fertilized variant	Fractions, %		Density g/cm^3	Apparent density, g/cm^3	Poro-sity, %	Penetration resistance, kg F/cm^2
	<0,001 mm	<0,01 mm				
Unfertilized control	25.9	45.9	2.66	1.26	52.6	23.4
Manure, 50 t/ha once in 4 years	26.3	45.4	2.64	1.22	53.8	20.1
Manure, 100 t/ha once in 4 years	25.8	45.7	2.63	1.18	55.1	13.3

The increase of the organic matter contents in the fertilized variants results in the decrease of density and the soil apparent density. These modifications have led to the increase of the lacunar space up to 55 %, value that refers the soil to the "high" class. The penetration resistance value decreased by about 10 kg F/cm^2 or by 43 % compared to the control variant.

The improvement of agro-physical and agro-chemical indicators of the moderately eroded common chernozem through the application of organic fertilizers conditioned the increase of crop yield (table 4).

Table 4

The impact of organic fertilizers on agricultural crops production grown on moderately eroded common chernozem, q/ha

Fertilized variant	Control variant yield and the increase on the fertilized variants									
	1997 winter barley	1998 corn for seeds	1999 mash (oats + peas)	2000 winter wheat	2001 corn for seeds	2002 winter barley	2003 corn for seeds	2004 sun-flower	2005 winter wheat	total cereal units for 9 years
Unfertilized control	29.6	33.3	56.6	12.4	31.7	14.3	34.2	12.7	14.3	198.7
Straw, 4 t/ha once in 4 years + $N_{60}P_{60}$	6.4	11.0	24.0	2.4	5.2	2.7	7.3	3.1	3.1	46.9
$N_{60}P_{60}$	6.6	-	8.3	1.3	5.5	2.4	5.2	1.2	2.1	39.9
Manure, 50 t/ha once in 2 years	7.6	12.8	11.1	5.3	12.8	7.1	15.3	7.4	6.7	78.5
manure, 50 t/ha once in 4 years	7.4	8.6	8.6	4.2	10.4	8.2	11.3	6.3	8.6	67.7
Manure, 50 t/ha once in 4 years + + $N_{60}P_{60}$	9.5	10.7	70.8	6.5	13.3	9.4	12.4	7.1	9.4	92.6
Manure, 100 t/ha once in 4 years	17.7	11.7	26.9	8.0	10.8	11.3	10.1	8.2	10.0	96.4
Manure, 150 t/ha once in 6 years	10.3	15.9	41.4	11.4	11.4	10.4	16.2	9.2	11.7	107.7
Manure, 200 t/ha once in 8 years	7.8	17.5	48.6	13.7	13.5	12.3	8.3	7.5	10.5	103.3
Compost, 100 t/ha (prepared from manure, 80% and alluvial soil, 20%)	6.2	13.7	26.6	11.1	7.2	3.1	5.8	3.9	2.6	60.1

CONCLUSIONS

1. The applied organic fertilizers on the given soils led to an essential increase of the humus contents. The increase of the humus contents on the fertilized variants for the period of ten years constituted 0.41-0.72%. The mobile forms of nutritive elements increased. The increase of mobile phosphorus and changeable potassium increased by 1.73-2.03 mg/100g and 2.9-8.3 mg/100g of soil, respectively.

2. Organic fertilization of moderately eroded ordinary chernozem has also led to the reduction of clod fractions (>10 mm) by 24.0-26.6%, thus increasing simultaneously the structural formations by 6.0-11.2%. The mechanical properties of the soil have improved as well. The penetration resistance value decreased by 43% compared to the control variant.

3. In the course of nine years of impact, an increase in the crop yield by 46.9 -107.7 q/ha cereal units was observed on all the variants.

4. It has been established that on the soils affected by erosion a dose of 50 t/ha of manure should be applied once in four years.

5. The manure originating from any animals, sludge, solid residues coming from the agricultural production processing and other organic wastes can be used as organic fertilizers.

6. In the case of insufficient resources for organic fertilizers, it is recommended to use a type of compost mixed with alluvium soil. The obtained compost made of 80 % manure + 20 % alluvial soil should be applied in a dose of 100 t/ ha once in 4-6 years.

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