LOCAL ORGANIC WASTES - IMPORTANT SOURCE FOR SOIL FERTILITY REMEDIATION

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Abstract

Soil fertility and productivity restoration may be ensured partially from the local sources of organic matter as: byproducts of livestock sector (cattle, pigs, sheep, goats, horses and poultry manure), crop wastes (straw, organic crop residues, green fertilizers), alcoholic beverages production wastes (wine yeast, vinasse, distillers grains). The mentioned wastes are biologically and chemically very active, are in permanent transformation, have the strongest and diverse pollutant load. At the same time, they contain elements essential for plant life that help improve soil fertility and increase crop productivity.

Key words: crop productivity, organic waste, soil fertility

Soil is the main natural resource of the Republic of Moldova. Food security, economic potential, and people' well-being of our country are based on soil. Unfortunately, soils of the Republic of Moldova for many years are subject to different forms of degradation, the main being humus loss, compaction, soil structure degradation, nutrients deficiency, loss of biodiversity and different forms of soil erosion. Soil erosion is one of the main soil threats that can be observed in different parts of the country. According to the Land Cadaster of the Republic of Moldova on 01.01.2010 the area of the eroded soil was about 880 thousand ha or 40% of the agricultural land. The area of heavily eroded soils with low productivity is over 110 thousand ha. These soils are widespread in the central and southern part of Moldova. During the last 40 years the surface of the eroded soils has increased by about 283 thousand ha or 7.0 thousand ha annually. The annual damage caused by erosion is estimated at 2.5 billion lei or 200 million US dollars.

Restoration of eroded soils under the current economic and management conditions is possible partially and gradually by use of local organic fertilizers in conditions of a well-managed anti-erosion background. This actions requires large quantities of organic matter, which play an important role in remedying the agrophysical, agrochemical and biological properties of the soil and in the mineral nutrition of the plants.

Use of local organic wastes as fertilizers will also have a positive effect on the other forms of soil degradation, that are not less harmful and requires similar attention from both agricultural producers and the government.

Since the agrarian reform (1990), agricultural production is formed, in most of cases, on the base of soil natural reserves. These resources are being exhausted from year to year, and the crops are becoming lower. Chemical fertilizers are introduced at minimal necessary quantities, enough only for crop production, and usually are represented by nitrogen fertilizers. Organic fertilizers are sometimes applied only at smallholder's farms. In these conditions it is necessary to resume the application of local organic fertilizers produced from various organic wastes. Thus, two major social-economic problems would be solved at the same time: conservation of agricultural soil fertility and elimination of organic wastes as sources of environmental pollution.

In this regard, the Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo" (IPAPS) has developed procedures and technologies of production and rational application of organic fertilizers, but unfortunately, these recommendations are less applied. In these conditions, we consider it is appropriate to remind about organic wastes as the valuable reserves of organic matter that can maintain and increase soil fertility, instead of being an environment pollutant, which happens in most cases.

The main purpose of this paper is to draw the attention of agricultural producers to the application of local (cheap) organic wastes for

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fertilization of agricultural crops in order to maintain soil fertility and increase crop production.

MATERIAL AND METHODS

Estimation of the influence of different fertilization methods with local organic wastes on the agrochemical and agrophysical properties of the degraded soils were carried out during the years 2010-2019 by the collaborators of the group Organic Fertilizers and Soil Fertility of IPAPS. The present paper is written basing on the researches within six field experiments founded in 2010 at the Experimental Station for Pedology and Erosion of IPAPS in Lebedenco commune, Cahul district; at the long-term Experimental Station of IPAPS in the village of Ivancea, Orhei district and the technological-experimental station "Codrii" in Chisinau.

RESULTS AND DISCUSSIONS

The main local sources of organic matter in the Republic of Moldova are animal by-products (livestock manure from cattle, pigs, sheep, goats, horses and poultry), plant residues (straw, organic crop residues, green manure) and wastes from the production of alcoholic beverages (wine yeasts, vinasse, distillers grains).

Table 1 shows the average values of the chemical composition of the local organic wastes in the Republic of Moldova.

Table 1

Average values of the chemical composition of local organic wastes with natural moisture in the Republic of Moldova (2010-2019)

Organic waste	Water content, %	Organic matter content, %	Total N, %	N-NH4, %	Total P2O5, %	Total K2O, %	Sum NPK, kg/t	N:P:K
Cattle manure	52.9	17.2	0.56	0.03	0.43	1.04	20.3	1:0,8:1,9
Pig manure	57.4	18.2	0.82	0.20	0.71	0.73	22.6	1:0,9:0,9
Sheep and goat manure	43.5	27.1	0.86	0.09	0.56	1.29	27.1	1:0,7:1,5
Poultry manure	51.0	26.0	1.46	0.48	2.39	1.16	50.1	1:1,6:0,8
Horse manure	54.6	16.7	0.73	0.04	0.48	0.84	20.5	1:0,7:1,2
Unfermented straw	12.0	81.0	0.74	0.08	0.20	1.81	27.4	1:0,3:2,4
The city sludge	47.8	43.5	0.88	0.24	1.18	0.39	24.5	1:1,3:3,9
Solid wine yeasts	48.0	47.0	1.50	3.29	0.70	2.50	47.0	1:0,5:1,7
Liquid wine yeasts	95.2	7.0	0.21	1.21	0.10	0.75	10.6	1:0,5:3,6
Vinasse	98.0	13.3	0.02	0.67	0.02	0.12	1.6	1:1:6,0
Distillers grains	93.0	6.2	0.28	0.14	0.12	0.11	5.1	1:0,4:0,4

Manure is considered to be the most representative and most spread organic fertilizer, with outstanding agrochemical and agronomic value. Currently, 2.5 million tons of manure is produced annually at the country level, making up 70% of the total quantity of local fertilizers. Unfortunately, manure is practically unused in recent years. Statistical yearbooks, which collect data from all types of agricultural producers, show that in 1990 out of 17.6 million tons of manure accumulated in the republic were incorporated only 10 million (55%). In 2010, the utilization rate was very low, on average 10 kg of manure per hectare, in comparison with 10 t/ha/year - the minimal recommended amount for one hectare necessary to maintain a neutral balance of humus in the soil.

Most of the manure remains and accumulates from year to year near the livestock farms, in private households or anarchically discharged on the roadside, on the banks of streams, creeks and other places absolutely contraindicated. These huge and ever-increasing quantities of manure have become the main source of environmental pollution in rural areas, especially of drinking water. Currently about 87% of the country's wells are characterized by a nitrate concentration above the maximum allowable norm (12 mg N-NO3 / l). The causes of such situations are the lack of knowledge regarding the fertilizing proprieties of the manure.

The main advantages of manure use are: improvement of the physical, chemical and biological properties of the soil; return of elements essential for plant life into the biological circuit and money saving from acquisition of mineral fertilizers; obtaining a crop increase of 100 cereal units from each ton of manure with a 60-90% profitability; prevention of environmental pollution with nutrients. Manure is recommended for basic fertilization of field crops and multiannual plantations. In crop rotations they usually follow sugar beet and fodder crops, corn for grain and for

silage. The application doses are 20-60 t/ha depending on the state of the soil, the crop needs and the amount of accumulated wastes (Plamadeala V., Bulat Ludmila, 2017).

The second very important source of organic matter is straw – byproduct of cereals growing. According to the statistical data, their annual amount makes 1.3 million tons. At present the straws, unfortunately, are not used. The most part of them is destroyed by burning directly in the field. It is an unacceptable action from the economic, ecological and moral point of view. Stubble burning leads to the loss of the source of organic matter so necessary for our soils; destruction of humus, nitrogen, sulfur in the soil; destruction of soil organisms; release of carbon, nitrogen, sulfur oxides, etc. into the atmosphere, causing the phenomenon of acid rains, reduction of oxygen content in the atmosphere and destruction of the planet's ozone protective layer.

The direct damage caused to the soil and the atmosphere by stubble burning is estimated at 17000 lei/ha. While the use of straw as an organic fertilizer has numerous benefits. First of all, humus content increase by 100 kg per 1 t of straw. Nutritive elements content also increases as follow: nitrogen - by 50 kg/1 t of straw; available phosphorus - by 10 kg/1 t of straw. The productivity of crop rotation increase by 130 kg cereal units per 1 t of straw. Soil water capacity increase by 13 mm per 1 t of straw. The profit is equivalent to 1600 lei/t of straw (Rusu Al., 2017).

The technology of applying straw as an organic fertilizer consists of straw shredding with the shredders KSK-100, E-281, KS-1,8, PON-5, and uniform distribution on the soil surface for mineralization of the organic substance of the straw. Because the straw is poor in azote it is recommended to add to each ton of straw 10 kg/ha of nitrogen, total 30-40 kg/ha. Fertilized soil is worked with disks, and ploughed late autumn (Rusu Al., 2009).

Green manure is also an important source of organic matter for soil. The following plants can be used as green manure: legume crops (peas, vetch, lupine, sainfoin, clover), some gramineae (rye, oats, raygrass) grown separately or in the mix. Green manure is recommended to be incorporated in the soil at the fenophase with a maximum biomass when plants are turgescent which coincides with their flowering. Prior to incorporation, the vegetable mass is rolled or chopped to promote the decomposition and mineralization of plants. Being incorporated into the soil the green fertilizers have the following effects:

- a significant input of organic matter with an essential role in the soil humus balance;
- green manure fertilizing effect is equivalent to 30-40 t/ha of manure;
- it is an important supply of nutrients, especially nitrogen due to its fixation from the atmosphere by legume crops
- stimulates biological activity of soil by increasing the number and efficiency of the ammonifying and nitrifying bacteria;
- physical ameliorative role, such as stabilizing of soil structure, restoration of the aerohydric regime of the soils;
- protection of soils from the erosion;
- significant increase of crop production.

Another source of organic matter, no less important for increasing soil humus reserves, are wastes from alcoholic beverages factories: wine yeasts and vinasse (from the wine factories) and distillers grains (from the ethyl alcohol production). The mentioned wastes are very active biologically and chemically. They are in permanent transformation and have the most powerful and diverse pollutant load. At the same time, they contain elements essential for plant life. In order to maintain a balanced level of nutrients in the soil, it is necessary to recover them from wastes and reintegrate them into the agricultural circuit by transforming and using them as fertilizer. The direct contribution of the organic matter from these fertilizers is also appreciable. It contributes to the increase of humus content, improvement of soil structure, water permeability increase and erosion and drought resistance (Siuris A., Plamadeala V., Ciolacu Tatiana, 2016).

Alcoholic beverages factories from the Republic of Moldova annually forms on average about 17 thousand tons of solid wine yeasts, 36 thousand tons of vinasse and 45 thousand tons of distillers grains. They contain about 28 thousand tons of organic matter, 180 tons of nitrogen, 82 tons of phosphorus and 257 tons of potassium. These wastes must be included in the agricultural circuit by their use as fertilizer.

Research conducted by IPAPS in 2011-2018 has shown that the above-mentioned wastes improve soil fertility of the chernozems and increase the productivity of agricultural crops. Fertilization with these wastes leads to an increase in organic matter content by 0.15-0.39%. Significant increase in nitric nitrogen (0.47-5.50 mg/kg), mobile phosphorus (0.20-0.64 mg/100 g soil) and exchangeable potassium (6.0-15 mg/100 g soil) was observed (Siuris A., 2017a).

The use of solid yeasts and vinasse ensures an annual increase of grape production (Sauvignon), respectively of 2,4 t/ha and 1,1 t/ha.

The applied distillers grains determines the annual production of 1200-1600 kg/ha of cereal units or an increase by 50-65% compared to the unfertilized control. It is worth mentioning that the physico-chemical composition of the wines obtained from the Sauvignon variety corresponds to the requirements of quality wines. The wines are characterized by good organoleptic qualities and correspond to the normative acts. The applied distillers grains increases the harvested mass of protein and fat by 50-60% compared to the control (Siuris A., 2017b, Siuris A., 2017c).

Based on the research carried out by the IPAPS during the mentioned period and the previous years, seven technologies models have been developed:

1) Preparation, storage and use of mixed manure from different animal species;
2) The valorization as fertilizer of the city sludge;
3) The direct valorization as fertilizer of unfermented straw (Rusu A., 2009);
4) The valorization of solid wine yeasts as a fertilizer (Siuris A., 2017c);
5) The valorization of liquid wine yeasts (Siuris A., 2018);
6) The valorization of vinasse (Siuris A., 2017b);
7) The valorization of distillers grains (Siuris A., 2017d).

We will mention that the rational production and use of organic fertilizers will solve two major problems: the first - ecological, by reducing the pollution of the environment with nutrients and the second - increase of soil fertility.

CONCLUSIONS

Fertilization of agricultural crops with local wastes contribute greatly to the quantitative and qualitative increase of the production, to the improvement of the physico-chemical properties of the soil, to the reduction of the degree of pollution of the environment (soil, groundwater, atmosphere) and of the final product.

Due to the application of local organic waste, significant financial benefits are obtained, due to the reduction of the costs of purchasing chemical fertilizers and the reduced quantities of used fertilizers.

The reduction of environmental pollution at the chaotic storage of organic waste will be achieved by using them as organic fertilizers for soil fertilization.

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