QUANTITATIVE AND QUALITATIVE CHANGES IN HUMUS AT USE OF WASTE FROM THE PRODUCTION OF ALCOHOLIC BEVERAGES

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Abstract

Modification of the humus content in the soil is the result of two processes with opposite trends: on the one hand occurs mineralization of a fraction of humus in order to ensure soil microorganisms and crops with nitrogen and other necessary elements, on the other occurs humus restoration on account of plant residues that remain in the soil and organic matter added as fertilizer. Chernozems of Moldova lost over 100 years about 25 percent of the accumulated organic matter. The critical level of Moldovan soils humification highlights as a primary problem: the preservation and increase of humus content, especially in soils affected by erosion. Stabilizing and increasing of humus content can be achieved by applying scientifically justified various wastes from the production of alcoholic beverages.

Key words: balance of humus, soil fertility, wastes, fertilizer

Soil organic matter plays an important role through its physicochemical and biological functions, serving as energy and nutritional source for microbial flora, and a factor on which largely depends soil fertility status. Humus is the most important deposit and, at the same time, the most significant source of carbon and nutrients.

Over 100 years Moldovan chernozems lost about 25 percent of accumulated organic matter (Krupenikov I., 2004). In the last 20 years the amount of organic fertilizers decreased 60 times and makes 0.1 t/ha, alfalfa area decreased by 4-5 times, crop residues are burned over large areas. The result is - negative balance of humus in the soil (0.7 t/ha) that with soil erosion losses are even bigger (-1.1 t/ha) (Andries S., 1999; Andries S., 2005). According to the latest estimates, on agricultural land are lost annually 26 million tons of humus (19 t/ha). Prognosis calculations show that in this situation, by 2025 the humus content in the soils of Moldova will decrease to the critical level of 2.5-2.8% (Andries S., Zagorcea C., 2002). Based on the above mentioned information, organic fertilization is the main agrotechnical measure that will positively influence the regime of soil humus. An essential source of organic matter in soil may serve wastes from the production of alcoholic beverages (wine yeast, vinasse and distillers grains). Discharging and accumulating without any control, that wastes causes serious pollutant impacts on the environment. Rational use of the last will partially solve two major problems: first – ecological, by reducing environment pollution, and the second - enhancing soil fertility.

MATERIALS AND METHOD

As object of research serve wastes from production of alcoholic beverages (wine yeast, vinasse and distillers grains) and two field experiences where they are incorporated. As the object of research is also used the soil from experiences (cambic chernozem) and plants grown on it, represented by annual crops and grape vines. Schemes of the experiences are presented in *tables 2* and *3*. The experiments were founded in 2011 in collaboration with the Scientific-Practical Institute of Horticulture and Food Technology at techno-experimental station "Codru", situated in the village Codru, mun. Chişinău. The chemical composition of wastes applied at the foundation of the experiences is shown in *table 1*.

For waste analysis were used the following methods: pH - GOST 27979-88; humidity - GOST 26713-85; organic matter - GOST 27980-88; total nitrogen - GOST 26715-75; total phosphorus - GOST 26717-85; total potassium - GOST 26718-85. In soil: total humus - Tiurin method; humic acids, fulvic acids and humin - Kononov-Belcikova method.

RESULTS AND DISCUSSIONS

Table 2 presents data that highlights the effects of fertilization with winery waste on the humus content in 0-30 cm layer of cambic chernozem.

It was found that doses of lees (13 and 26 t/ha per year) lead to a significant increase in humus content in the first, second and third year of

action. Humus increase compared to control in the three-year average was 0.14 and 0.29% respectively (3724 and 7714 kg/ha). Application of vinasse dose of 300 and 600 m^3/ha leads to statistically significant increases in the levels of humus content in the all three years of experimentation (2011-2013), where the growth compared to the control average was 0.25 and 0.36% (6650 and 9576 kg/ha).

Table 1

The chemical composition of wastes applied at the foundation of the experience

The chemical composition of waste applied to the founding experience	Wine yeast	Vinasse	Distillers grains
pH	3.4	3.5	3.7
Humidity, %	42.5	98.0	93.4
Organic matter, %	50.5	15.8	46.2
Total nitrogen, %	1.8	0.01	0.28
Total phosphorus, %	0.61	0.01	0.12
Total potassium, %	2.7	0.10	0.11

Table 2

Influence of wine wastes on the humus content in the 0-30 cm layer of cambic chernozem, % of soil mass. Techno-experimental station "Codru", 2013

Variant of the experiment	2011, the first year of the experiment		2012, the second year of the experiment		2013, the third year of the experiment		Mean for the 2011-2013 years	Increase compared to control	
	Humus	Increase	Humus	Increase	Humus	Increase		%	kg/ha
1. Control	4.28	-	4.25	-	3.90	-	4.14	-	-
2.Wine yeast (N100), 13 t/ha per year	4.39	0.11	4.38	0.13	4.08	0.18	4.28	0.14	3724
3.Wine yeast (N200), 26 t/ha per year	4.46	0.18	4.55	0.30	4.27	0.37	4.43	0.29	7714
4.Vinasse (K_{450}), 300 m^3/ha per year	4.44	0.16	4.63	0.38	4.11	0.21	4.39	0.25	6650
5.Vinasse (K_{900}), 600 m^3/ha per year	4.48	0.21	4.73	0.48	4.23	0.38	4.50	0.36	9576
DL 0.5%	0.10	0.10	0.11	0.11	0.10	0.14	0.12	0.12	3024
P, %	4.9	4.9	6.3	6.3	8.2	8.2	7.4	7.4	7.4

Table 3

Influence of corn distillers grains on the humus content in the 0-30 cm layer of cambic chernozem, % of soil mass. Techno-experimental station "Codru", 2013

Variant of the experiment	2012, the first year of the experiment		2012, the second year of the experiment		Mean for the 2012-2013 years	Increase compared to control	
	Humus	Increase	Humus	Increase		%	kg/ha
1. Control	2.97	-	2.94	-	2.96	-	-
2. Corn distillers grains (N_{120}), 47 m^3/ha per year	3.05	0.08	3.09	0.15	3.07	0.11	2772
3. Corn distillers grains (N_{240}), 94 m^3/ha per year	3.11	0.14	3.17	0.23	3.14	0.18	4536
DL 0.5%	0.06	0.06	0.11	0.11	0.09	0.09	2268
P, %	4.6	4.6	6.1	6.1	5.8	5.8	5.8

Influence of corn distillers grains on humus content in the arable layer of cambic chernozem is shown in table 4 and highlights the following:

- Fertilization with corn distillers grains at doses equivalent to 120 and 240 kg/ha led to a significant increase in soil humus content;

- Increase of the humus content in two years of experimentation were in average 0.11 and 0.18% (2772 and 4536 kg/ha).

Research regarding the influence of waste from the production of alcoholic beverages are shown in tables 4 and 5.

Table 4

The influence of wine yeasts on the composition of humus of cambic chernozem. Techno-experimental station "Codru", 2013

Variant of the experiment	C, %				$\frac{C_{HA}}{C_{FA}}$	E_{HA}, mg/ml	C_{MHA}	Degree of humification, %
	Total	HA	FA	H				
1. Control	2.27	0.81	0.28	1.18	2.93	27.5	0.78	36
2. Wine yeast (N_{200}), 26 t/ha per year	2.37	0.82	0.34	1.21	2.43	28.4	0.71	35
3. Vinasse (K_{900}), 600 m^3/ha per year	2.35	0.79	0.31	1.24	2.51	28.0	0.73	34
DL 0.5%	0.36	0.13	0.03	0.27	0.61	1.85	0.12	-
P, %	15.4	16.6	10.3	22.3	14.8	5.5	15.6	-

Table 5

The influence of corn distillers grains on the composition of humus of cambic chernozem. Techno-experimental station "Codru", 2013

Variant of the experiment	C, %				$\frac{C_{HA}}{C_{FA}}$	E_{HA}, mg/ml	C_{MHA}	Degree of humification, %
	Total	HA	FA	H				
1. Control	1.75	0.73	0.23	0.79	3.28	27.7	0.67	41
2. Corn distillers grains (N_{240}), 100 m^3/ha	1.74	0.74	0.23	0.77	3.21	26.4	0.67	43
DL 0.5%	0.14	0.22	0.09	0.054	0.09	0.79	0.032	-
P, %	8.2	3.2	11.5	6.9	7.1	2.9	4.8	-

It was found that the application of wine yeast and vinasse led to a significant accumulation of humic acids, which is characteristic to chernozem soils. At application of corn distillers grains this effect was not significant.

Incorporation of waste wine (wine yeast and vinasse) led to formation of a positive balance of humus, respectively 2.4 and 2.8 t/ha per year (*table 6*).

Table 6

Influence of wastes from the production of alcoholic beverages on the balance of humus in the soil arable layer determined by the direct method

Variant of the experiment	Initial content	The third year of the experiment	Humus balance		
			In three years		annually, t/ha
	t/ha		t/ha	%	
Cambic chernozem (0-30 cm). Station “Codru”, village Codru					
1. Control	169.6	170.8	-1.2	-1	-0.4
2. Wine yeast (N_{200}), 26 t/ha per year	184.7	177.6	+7.1	+4	+2.4
3. Vinasse (K_{900}), 600 m^3/ha per year	185.1	176.8	+8.3	+5	+2.8
Cambic chernozem. Station “Codru”, village Codru					
1. Control	74.6	76.1	-1.5	-2	-0.8
2. Corn distillers grains (N_{240}), 100 m^3/ha	79.1	74.1	+5.0	+6	+2.5

Corn distillers grains applied at a dose of 100 t/ha of humus formed a balance of 2.5 t/ha annually. In three years the quota of humification and mineralization of organic matter incorporated in the arable layer with wastes from the production of alcoholic beverages is presented in table 7. The obtained data reveals the following: from 1 tone of yeasts incorporated into the soil were obtained 159 kg of humus, from 1 tone of vinasse - 8 kg of humus and from 1 tone of corn distillers grains - 46 kg of humus.

Table 7

Quota of humification and mineralization in three years of organic matter incorporated into the arable layer with different wastes, kg

Variant of the experiment	Soil carbon			Humus obtained from 1 tone of waste
	Introduced with fertilizers	Humificated	Mineralized	
Cambic chernozem. Station "Codru", village Codru				
1. Control	-	-	-	-
2. Wine yeast (N_{200}), 26 t/ha per year	6084	2981	3684	159
3. Vinasse (K_{900}), 600 m^3/ha per year	4620	2171	1820	8
Cambic chernozem. Station "Codru", village Codru				
1. Control	-	-	-	-
2. Corn distillers grains (N_{240}), 100 m^3/ha	2980	1669	480	46

CONCLUSIONS

Wine yeast, vinasse and distillers grains were used as fertilizer in the experiment in medium doses. They enriched soil significantly with humified organic matter. The increase of humus in the plowed layer from 1 tone of wastes was: wine yeast 95-99 kg; vinasse 5-7 kg; distillers grains 24-29 kg.

Degree of humification of organic matter introduced with the wastes has been relatively constant, fluctuating within 35-43%, with a coefficient of humification of 0.36%. Therefore 36 percent of organic matter incorporated with wastes in three years were turned into humic and fulvic acids. There were accumulated predominantly humic acids, which is characteristic for chernozem soils. The ratio of humic acid to fulvic acid in the experiments ranged from 2.5 to 3.3.

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