

RESEARCH REGARDING THE USE OF GRAIN MASH AS SOIL FERTILIZER

Andrei SIURIS, Tatiana CIOLACU

“Nicolae Dimo” Institute of Soil Science, Agrochemistry and Soil Protection, 100 Ialoveni Str.,
MD-2070, Chisinau, Republic of Moldova

Corresponding author email: siurisandrei@mail.ru

Abstract

The work presents research results regarding the use as fertilizer of grain mash, a waste from alcohol production industry. Annually there are produced up to 55 thousand m³ of grain mash in the Republic of Moldova, which need to be used without adversely affecting the environment. Grain mash contains about 93% of water, 5% of organic matter. One cubic meter of grain mash contains on average 2.8 kg of total nitrogen, 1.2 kg of phosphorus and 1.1 kg of potassium. It was established that grain mash used as fertilizer increases productivity of field crops by 40-50%. In conclusion, grain mash should be used as fertilizer.

Key words: grain mash, fertilization, agrochemical indices, fertilizer, yield.

INTRODUCTION

Grain mash (of wheat, barley or maize), potato mash and molasses are by-products of factories of ethyl alcohol production. Annually in the Republic of Moldova, from 20 enterprises existent in the country accumulates about 45 thousand tons of this wastes (Statistical Yearbook of the Republic of Moldova). Until the agrarian reform in '90 years, grain mash was used as animal feed at the animal farms. With the dissolution of large farms and reduction of livestock, in generally, that possibility disappeared and nowadays alcohol producers are facing daily serious problems related with wastes disposal and environmental legislation. Grain mash, in the most of cases, is thrown into the environment, somewhere near the fabrics, thus causing pollutant impacts especially on soil and surface waters. At the same time, grain mash contains basic elements so necessary for plant growth, nutrition and soil fertility maintenance. In this context, alcohol producers of our country face a huge issue related with disposal of wastes, that must solved urgently - the issue of using this wastes. International researches in this domain are not so many (Korceaghina, 2012; Nicolic and Petresca, 2006; Nenaidenko et al., 1988) and in the Republic of Moldova in generally were not made until recent time. We consider that the

use of grain mash as soil fertilizer will partially solve the three social and economic problems: partial recovery of soil fertility, increase of plants productivity and protecting the environment from pollution with wastes. The purpose of this paper is to appreciate fertilizing potential of grain mashes resulted from the production of ethyl alcohol.

MATERIALS AND METHODS

As study material of our research served waste from the production of ethyl alcohol - grain mash. Research and observations, for the appreciation of potential of grain mash as fertilizer, were conducted during 2011-2014 years at technological-experimental Station "Codru". Grain mash incorporated into the soil contained on average 0.25% N, 0.10% P₂O₅ and 0.08% K₂O.

The studied soil was slightly eroded leached chernozem of clay-loamy texture, moderate humus content of 3.52%; P₂O₅ - 3.12 mg/100 g soil; K₂O - 30 mg/100 g soil (by Machighin method); pH - 6.8; hydrolytic acidity - 2.71 me/100 g soil. Experience scheme is presented in Table 3. The experience was founded in four repetitions (Figure 1).

The area of each experimental plot was 120 m² (6 m x 20 m). Chemical and physico-chemical analyses of grain mash, soil and plants were

made according to approved or adopted standards in the Republic of Moldova. Statistical analysis was performed by the method of dispersion and correlation with the use of MS Excel program.



Figure 1. Foundation of the experience

RESULTS AND DISCUSSIONS

Research shown that grain mash from alcohol production is characterized by a water content of 93.4% and 6.63% dry matter (Table 1).

The average pH value is 3.7 units. They contain a huge amount of organic matter (5.1%) and a varied content of primary elements: 0.21 to 0.33% total nitrogen, total phosphorus 0.06-0.19% and potassium total 0.09-0.13%. The amount of nutrients (NPK) that are contained in a cubic meter of waste is an average of 5.1 kg. The ratio of carbon:nitrogen is 9:1.

The three-year average data have shown that fertilization of leached chernozem with grain mash contributed to a significant increase in organic matter content and mobile forms of nutrients (Table 2). In the arable layer, compared to the control (2.93%) humus content value increased by 0.15-0.25% on fertilized variants or by 3.8 to 6.3 t/ha.

There was a significant increase in mobile phosphorus content by 0.21-0.46 mg/100 g soil or 0.5-1.0 t/ha and in exchangeable potassium by 3-6 mg/100 g soil or 0.7-1.4 t/ha.

Our research showed that grain mash applied as fertilizer act beneficially on the productivity of field crops (Table 3).

Mash grains applied annually at a dose of 47 and 94 m³/ha (equivalent to N₁₂₀ and N₂₄₀) resulted in the average yield increase in three years of 1221 and 1597 kg/ha grain units

respectively, or 50-65% in comparison with unfertilized variant (Figures 2, 3 and 4).



Figure 2. Sunflower fertilized with grain mash



Figure 3. Winter wheat fertilized with grain mash

In harvest of field crops on variants fertilized with grain mash in doses 47 and 94 m³/ha (equivalent to N₁₂₀ and N₂₄₀) annually, it was established a higher protein content (Table 4). Application of grain mash not only increased concentration of substances in filed crops but favoured yield increase itself. It was noticed that weight of harvested protein and fat was significantly increased compared to the witness. The weight of the collected protein in three years was higher in comparison with the reference plants by 577-650 kg/ha or 86-97%. Fertilization with grain mash conducted to growth of wet gluten content and crude protein content in wheat by 6.7-7.0% and 2.1-3.3% respectively in comparison with unfertilized control plot. At the same time nitrogen content grow by 0.36-0.58%. There were no statistical modification in phosphorus and potassium content of wheat grains.

Table 1. Chemical composition of grain mash from the production of alcohol (n = 10)

Water content, %	Organic matter, %	Total forms, %			kg/m ³			Sum NPK, kg/m ³	Ratio C:N
		N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O		
93.4	5.1	0.28	0.12	0.11	2.8	1.2	1.1	5.1	9:1

Table 2. Influence of fertilization with grain mash on agrochemical indicators in arable layer of leached chernozem

Variant of the experience	Organic matter, %			P ₂ O ₅ , mg/100 g sol			K ₂ O, mg/100 g sol		
	Mean	Increase compared to control		Mean	Increase compared to control		Mean	Increase compared to control	
		%	t/ha		mg/100 g	t/ha		mg/100 g	t/ha
1.Witness	2.93	-	-	2.31	-	-	26	-	-
2.Grain mash, 47 m ³ /ha per year	3.,08	0.15	3.8	2.52	0.21	0.5	29	3.0	0.,7
3.Grain mash, 94 m ³ /ha per year	3.18	0.25	6.3	2.77	0.46	1.0	32	6.0	1.4

Table 3. Effects of fertilization with grain mash on field crops productivity, kg/ha

Variant of the experiment	Grape harvest on the years			On average, grain units		
	2012, sunflower	2013, winter wheat	2014, sunflower	Crop	Crop increase compared to witness	
					kg	%
1.Witness	1230	3818	1170	2449	-	-
2.Grain mash, 47 m ³ /ha per year	1840	5673	1790	3670	1221	50
3.Grain mash, 94 m ³ /ha per year	2070	6183	1980	4046	1597	65
DL _{0,5%}	223	520	172			

Table 4. Quality indices of main production formed under the action of grain mash

Indices and units	Variant of the experiment		
	1.Witness	2.Grain mash (N ₁₂₀), 47 m ³ /ha per year	3.Grain mash (N ₂₄₀), 94 m ³ /ha per year
Year 2012, sunflower			
Protein content, %	16.2	16.3	16.2
Quantity of protein, kg/ha	199	300	335
Increase of protein, kg/ha	-	101	136
Fat content, %	43.7	42.7	42.6
Quantity of fat, kg/ha	538	786	882
Increase of fat, kg/ha	-	248	344
Year 2013, winter wheat			
Protein content, %	7.9	11.2	10.0
Quantity of protein, kg/ha	302	635	618
Increase of protein, kg/ha	-	333	316
Fat content, %	22.9	29.6	29.9
Quantity of fat, kg/ha	874	1679	1848
Increase of fat, kg/ha	-	805	974
Year 2014, sunflower			
Protein content, %	14.2	17.3	18.4
Quantity of protein, kg/ha	166	309	364
Increase of protein, kg/ha	-	143	198
Fat content, %	51.8	48.7	48.7
Quantity of fat, kg/ha	606	872	964
Increase of fat, kg/ha	-	266	358
Total protein increase in three years:			
kg/ha	-	577	650
%	-	86	97

CONCLUSIONS

In a cubic meter of grain mash from production of alcohol contained in average: 2.8 kg of nitrogen, 1.2 kg of total phosphorus and 1.1 kg of total potassium, in sum they make 5.1 kg/m³. Application of grain mash on leached chernozem led to an increase in organic matter content of 0.15-0.25% (3.8 to 6.3 t/ha). There was a significant increase in mobile phosphorus from 0.21 to 0.46 mg/100 g (0.5-1.0 t/ha) and exchangeable potassium 3-6 mg/100 g soil (0.7-1.4 t/ha).

Fertilization with grain mash resulted in average yield increase in three years of 1200-1600 kg/ha of grain units or 50-65% compared to the unfertilized control. The mass of the collected protein in three years increased compared to the witness by 570-650 kg/ha or 86-97%.

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