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RESEARCH REGARDING THE POSSIBILITY OF USE THE WINE YEAST AS FERTILIZER

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Abstract

It was studied the possibility of use as fertilizer the wine yeast, a wine industry waste which results from the settlement of wine after fermentation. Its amount ranges from 12 to 15% of the wine. It has a very heterogeneous composition contains a number of precipitated substances such as tartrates, proteins, polyphenols, polysaccharides, pectin, fats, minerals. The complex and valuable composition of wine yeast show that its utilization is useful both economically and socially, as an indispensable mean to reduce pollutant load of wine cellars and distilleries.

Key words*: vine, Sauvignon grapes, white wine, wine yeast, organic fertilizer.*

INTRODUCTION

The wine making technology is a complex technological process during which approximately 70% of raw material is used to make the wine. The amount of 30% accumulates as waste (wine yeast) that may represent about 40-80 thousand tons per year (Statistical Yearbook, 2012).

Winemaking also causes environmental problems because of the fact that neutralization process and use of fermentation wastes that are mixed with cyanide compounds containing heavy metals (iron, copper, etc.) that are forming during production of the raw wine represent an evident danger to the environment and human health (Duca, 2011; Ruggieai et al., 2009).

At the same time, wine yeast contains the basic elements necessary for plant nutrition and soil fertility that strongly need to be recovered. One hundred cubic meter of wine yeast contains approximately 190 kg of total nitrogen, 190 kg of phosphorus and 550 kg of total potassium. Based on the above mentioned facts, it was founded a field experiment aiming to highlight fertilizer potential of wine yeast as bio-organic fertilizer with beneficial effects on plants, soil, end products and environment, and with a high economic return. Its rational use in agriculture will solve two major problems: the first – environmental, through reducing environmental pollution and the second – sustainable use of land resources, through soil fertility increase.

MATERIALS AND METHODS

Research and observations were made in 2011-2012 at the Experimental Station "Codru" of Practical Scientific Institute of Horticulture and Food Technology. The experimental field was located on a north-eastern slope with inclination 2-3° (Figure 1).

At the plantation of grape-vine in 1998 soil was deep tilled at a depth of 60 cm with the incorporation of 100 t/ha manure. In the experiment was planted Sauvignon variety. Rootstock cuttings were raised on the type Riparia x Ruperstris 101-14. Scheme of seedlings location is 1.5-2.3 m. The studied soil was a clayey-silty on clay loam leached (cambic) chernozem with a very deep humus profile. The physical-chemical properties of the soil are shown in Table 1.

Experience was founded in three repetitions. The surface of a plot is 55 m^2 (4.6 m x 12 m). Wine yeasts were applied manually. Experience scheme is shown in Table 3.

Each year soil samples were collected from fixed points on the plots for laboratory

analysis. Soil maintenance practices are performed in accordance with the recommendations of technological maps for growing bearing vines. There is liquid wine yeast that results after alcohol extraction and solid yeast obtained after filtration (pressing). In our case were incorporated solid wine yeasts (Figure 2).

Solid wine yeast has a content of 48% water, 46.8% minerals, 5.3% organic matter (Table 2). Among the biofile elements dominate potassium, nitrogen and total phosphorus. One ton of yeast contains 48 kg NPK.

The ratio of these elements is approximately 1.0:0.5:1.7 that corresponds to the needs of vine plant. Carbon-nitrogen index is 16:1, being similar, by capacity to release nitrogen, with mixed manure (17:1).

Chemical and physico-chemical analysis of solid wine yeast, soil, grapes and wines were made by the standards adopted or approved in the Republic of Moldova. Statistical analysis was performed using the method of dispersion and correlation using MS Excel program.

Figure 1. Experimental plot

Figure 2. Solid wine yeast used in the experiment

Table 1. Physical-chemical characteristics of cambic chernozem from the Experimental Station „Codru”

Horizon and depth, cm	pH (H_2O)	$CaCO_3$	Humus content	total N	C:N	Mobile forms, mg/100 g sol		Exchangeable cations, me/100 g sol		
		%				P_2O_5	K_2O	Ca^{2+}	Mg^{2+}	Suma
Ap1 0-16	6.8	0	4.64	0.22	12.2	3.42	43	25.2	3.2	28.4
Ap2 16-43	6.6	0	3.97	0.20	11.5	1.76	16	24.8	4.0	28.8
A 43-80	6.6	0	3.59	0.18	11.4	1.23	15	24.4	4.8	29.2
B1 80-97	6.8	0	1.92	0.11	10.1	0.72	14	23.6	2.8	26.45
B2 97-114	7.6	4.7	1.41	0.08	10.2	0.60	14	24.0	4.0	28.0
BC 114-150	8.0	16.1	0.85	0.06	8.2	0.36	12	20.0	4.0	24.0
BCk 150-195	8.1	14.3	0.56	0	0	0.20	12	18.8	5.2	24.0
Ck 195-205	8.2	13.2	0.36	0	0	0	11	18.0	5.2	23.2

Table 2. Chemical composition of solid wine yeast from wine-making plants used during the experiment (2011-2012), by weight with natural moisture content

Index and measure unit	x	min	max	S	Vm, %	Sx	Sx%	Δx (+,-)
pH	3.5	3.2	3.7	0.1	3.5	0.1	2.0	0.2
Moisture content, %	48.0	42.0	58.9	9.6	20.0	5.5	11.6	18.0
Organic matter content, %	46.8	38.3	50.3	9.5	20.3	5.5	11.7	17.6
Ash, %	5.3	2.8	8.8	3.1	55.0	1.7	32.0	5.1
Carbon, %	23.4	19.2	25.5	1.2	5.2	0.6	2.6	2.0
Total nitrogen, %	1.5	0.8	1.81	0.6	40.0	0.4	23.0	1.1
N-NO_3, mg/100 g	1.6	0.7	2.8	0.7	42.5	0.3	0.002	1.0
N-NH_4, mg/100 g	32.9	26.9	51.7	2.4	7.3	1.1	3.3	3.6
Total phosphorus, %	0.70	0.6	0.8	0.1	18.5	0.1	10.6	0.2
Total potassium, %	2.6	2.3	2.7	0.3	10.2	0.2	5.8	0.5

RESULTS AND DISCUSSIONS

The research shown that fertilization of cambic chernozem wine yeast led to a significant increase of humus content (Table 3).
At the second year of the experiment humus content increased by 0.11-0.18% in comparison with its initial content (before the incorporation of wine yeast). Also in variants fertilized with yeast increased content of mobile forms of phosphorus and potassium, respectively from 0.47 to 0.72 and from 4.8 to 5.0 mg/100 g soil.

Application of different doses of solid wine yeast did not essentially change the content of soluble salts, soil reaction and aqueous extract composition (Table 4).
The composition of soluble salts remained the same, which is determined by the presence of calcium bicarbonate [$Ca(HCO_3)_2$] and less by magnesium sulfate ($MgSO_4$). Stability of the saline indices and soil pH of cambic chernozem to the action of wine yeasts can be explained by the high buffering capacity of the soil.

Table 3. Modification of agrochemical indices in the 0-30 cm layer of cambic chernozem at the application of solid wine yeast, 2012 (Experimental Station "Codru")

Fertilization variant	Humus content	$N\text{-}NO_3$	P_2O_5	K_2O
2011 (before incorporation of wine yeast)				
1. Unfertilized control	4.28	0.74	2.03	28
2. Wine yeast (N_{100}), 13 t/ha	4.44	0.70	2.21	27
3. Wine yeast (N_{200}), 26 t/ha	4.45	0.90	2.21	28
2012 (increase in comparison with initial content)				
1. Unfertilized control	0.03	0.07	0.05	-0.04
2. Wine yeast (N_{100}), 13 t/ha	0.11	0.47	0.47	4.8
3. Wine yeast (N_{200}), 26 t/ha	0.18	0.51	0.72	5.0
DL 0.5%	0.06	0.12	0.19	3.2

Table 4. Influence of wine yeast on ionic composition of aqueous extract of cambic chernozem in arable layer, 2012 (Experimental Station "Codru")

Fertilization variant	pH (H_2O)	Dry residue, %	HCO_3^-	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	K^+	Na^+
			me/100 g sol						
1. Unfertilized control	7.3	0.039	0.36	0.07	0.22	0.38	0.19	0.02	0.06
2. Wine yeast (N_{100}), 13 t/ha	7.2	0.041	0.24	0.07	0.33	0.35	0.18	0.02	0.09
3. Wine yeast (N_{200}), 26 t/ha	7.0	0.046	0.15	0.07	0.48	0.39	0.19	0.02	0.10

Application of solid wine yeast in doses 13 and 26 t/ha provided an increase of grape harvest on average in two years 1.05-1.15 t/ha or with 12-13% more than at the unfertilized control 8.7 t/ha (Table 5). Total yield at the incorporation of solid wine yeast in two years was in average 19.5-19.7 t/ha of Sauvignon grapes.

Table 5.Influence of solid wine yeast on the grapes yield grown on the cambic chernozem at the Experimental Station "Codru", 2011-2012

Fertilization variant	2011			2012			total yield		
	t/ha	increase		t/ha	increase		t/ha	increase	
		t/ha	%		t/ha	%		t/ha	%
1. Unfertilized control	9.8	-	-	7.6	-	-	17.4	-	-
2. Wine yeast (N_{100}), 13 t/ha	10.8	1.0	10	8.7	1.1	14	19.5	2.1	12
3. Wine yeast (N_{200}), 26 t/ha	10.9	1.1	11	8.8	1.2	15	19.7	2.3	13
DL 0.5%		0.6			0.7				

To conduct oenological research on wine quality from the experimental vine plantation were harvested grapes from all three variants. In the extracted juice were determined alcohol concentration, sugar content, titratable and volatile acidity, mass concentration of the sulfuric acid and pH of wines. The obtained results are shown in Table 6.

White wine obtained from Sauvignon yield of 2011 is characterized by high values of alcohol concentration (12.6-12.6% vol.) and moderate values of titratable acidity (8.1-8.6 g/dm^3).
It should be mentioned that fertilization of vine plantations with wine yeast had a insignificant influence on physical-chemical indices of wine.
Organoleptic analysis of white wine from Sauvignon variety revealed its beneficial quality, score rating in limits of 7.79-7.88 of points.
On the basis of the obtained results and the results of tasting session it should be mentioned that use of wine yeast as fertilizer in doses of 13-26 t/ha, in the second year of the experiment did not diminished quality of the obtained wine.

Table 6. Physical-chemical indices of wine from variety of white grapes Sauvignon, 2012

Characteristics / Variant	**Unfertilized control**	**Wine yeast (N_{100}), 13 t/ha**	**Wine yeast (N_{200}), 26 t/ha**
Grapes yield, kg	50	50	50
Sugars concentration, g/dm^3	206	226	231
Alcohol, % Vol.	12.61	12.64	12.84
Titratable acidity, g/dm^3	8.55	8.55	8.10
Volatile acidity, g/dm^3	0.66	0.66	0.79
Total sulfur dioxide, mg/dm^3	89.6	153.6	153.6
Free sulfur dioxide, mg/dm^3	11.52	15.36	14.08
pH	3.10	3.12	3.15
Organoleptic score	7.88	7.83	7.79

CONCLUSIONS

Application of wine yeast in doses 13-26 t/ha on cambic chernozem in the second year of the experience contributed to a moderate increase of humus content in arable layer (0.11-0.18%).
A significant increase of mobile phosphorus (0.47-0.72 mg/100 g soil) and exchangeable potassium (4.8-5.0 mg/100 g soil) was established.
Incorporation of doses 13-26 t/ha of wine yeast in the second year of action did not modified soluble salts content, soil pH and aqueous extract composition. Fertilization with wine yeast in doses 13-26 t/ha at vine cultivation during two years formed the total yield of 19.5-19.7 t/ha, ensuring a growth of grapes yield about 2.1-2.3 t/ha (or 12-13%).
Incorporation of wine yeast as a fertilizer on cambic chernozem did not have a negative action on white wine quality obtained from Sauvignon variety. The researches in that direction are going to be continued.

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