USE OF VITREOUS FERTILIZERS WITH SLOW RELEASE OF NUTRIENTS IN VITICULTURE

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Abstract

An experiment was conducted to study the possibility of using vitreous fertilizers made from waste from the glass industry in vineyards fertilization. Six recipes were tested having as composition the basic elements: P2O5 (43.5%), K2O (32.6%), MgO (18.5%) and CaO (5.4%), plus the presence of some micronutrients (B, Fe, Zn, Mo, Mn) as oxide form. The efficiency of these fertilizers was made in comparison both with an unfertilized plot and an fertilized plot with NPK applied on the base of optimal rates.

The experimental results have shown that this type of fertilizers can replace the use of common chemical fertilizers, their effect on the fertility and productivity of grapevine being relative similar, the benefit consisting of slow release over a long period of time of the nutrients from their composition with positive effects in preventing environmental pollution. The presence of micronutrients in their composition determined even higher yields (by 10-19%) as compare to chemical fertilization and a higher content (by 8-45 %) of anthocyanins in grapes when vitreous fertilizers had B, Fe, Zn and Mo in their composition.

Keywords: fertilization, micronutrients, grapevine, wines

1. INTRODUCTION

Grapevine is a woody perennial plant with a long period of vegetation (mean 180 days) which involves a differentiated absorption of nutrients from soil during a long period of time. For this reason the vineyard fertilization requires the use of chemical fertilizers with slow release of nutrients in the soil during a long period of time, in order to ensure the nutritional requirements of grapevine throughout the growing cycle (Condei, 1982; Bernaz, Dejeu, 1999; Fregoni, Bavaresco, 2000; Fregoni 2005; Dejeu, 2010).

In this respect, an two years experiment was conducted in order to study the possibility of using vitreous fertilizers obtained from waste from the glass industry in grapevine fertilization.

2. MATERIAL AND METHOD

Vitreous fertilizers represent a new category of fertilizers which are made from a glass matrix with slow and controlled solubility in soil solution containing useful macronutrients for grapevine nutrition such as: P, K, Ca, Mg in which some micronutrients such as: B, Mo, Fe, Mn, Zn are injected in different proportions.

The chemical composition of vitreous fertilizers used in the experiment is presented in table 1.

Table 1. Chemical composition of vitreous fertilizers used in the experiment

Vitreous fertilizer	Chemical composition %								
	P_2O_5	K_2O	MgO	CaO	B_2O_3	Fe_2O_3	ZnO	MnO_2	MoO_3
AG 3	43.48	32.61	18.48	5.43	-	-	-	-	-
AG 3.1 (B)	39.65	29.73	16.85	4.96	8.81	-	-	-	-
AG 3.2 (Fe)	40.57	30.43	17.25	5.08	-	6.67	-	-	-
AG 3.3 (Zn)	42.42	31.81	18.03	5.31	-	-	2.43	-	-
AG 3.4 (Mn)	42.15	31.61	17.91	5.27	-	-	-	3.06	-
AG 3.5 (Mo)	42.21	31.66	17.94	5.28	-	-	-	-	2.91

As compared with the chemical classical fertilizers, these fertilizers present the following advantages:

- greater use of nutrients by grapevine because these fertilizers don't turn into insoluble compounds in soil solution
- keeping in the soil throughout the ontogenetic cycle of grapevine
- lack of ground water pollution risk.

The experiment was carried out between 2009-2010 in a hilly area from Valea Calugareasca viticultural centre, in a vineyard planted with Merlot/5BB variety. The soil of the experimental plot was a red vertic prevosoil with a medium texture and fertility.
The main agrochemical characteristics of the soil are presented in the table 2.

Table 2. The main agrochemical characteristics of the soil from the experimental plot

Horizon	**Depth cm**	**Clay <0.002 %**	**pH H_2O**	**Humus %**	**P mobile ppm**	**K mobile ppm**	**$CaCO_3$ total %**
(Ao+AB)dKs	0-20	44.7	6.8	1.72	68	152	4.9
(AB+Bt)d	30-50	47.2	6.3	1.12	76	168	4.2
(Bt+AB)d	56-67	40.8	5.0	1.18	60	152	5.6
AB	75-95	49.7	5.1	0.70	58	136	4.8
Bt(w)	120-140	47.9	6.1	0.46	60	140	4.4
BC w	160-180	50.9	7.5	0.52	50	130	8.3

In order to quantify the effect of the six vitreous fertilizers used in the experiment on the quantity and quality of the grapevine yield it was used a layout based on randomized blocks with two control treatments: one of them was an unfertilized treatment, the other one was a fertilized treatment with a complex P and K fertilizer.

The following parameters were determined:

- the evolution of the main agrochemical characteristics of the soil
- the grapevine mineral nutrition (macro and micronutrients)
- the grapevine fertility and productivity indexes
- the grapevine yield and quality of the grapes
- the main chemical characteristics of the wines.

3. RESULTS AND DISCUSSIONS

The experimental data obtained show an evident influence of the vitreous fertilizers on the main agrochemical characteristics of the soil (table 3).

Table 3. Influence of vitreous fertilizers on the main agrochemical characteristics of the soil (average of 0-60 cm)

Treatment	**NH_4+NO_3 ppm**	**P mobile ppm**	**K mobile ppm**
Unfertilized control	3.34	61.3	160.0
P and K fertilized control	3.48	86.0	184.0
AG 3	3.25	86.7	192.0
AG 3.1 (B)	3.44	90.0	188.7
AG 3.2 (Fe)	3.21	114.7	256.0
AG 3.3 (Zn)	3.54	126.7	264.0
AG 3.4 (Mn)	2.96	90.0	200.0
AG 3.5 (Mo)	3.13	90.7	197.3

This influence is more evident in case of the amount of mobile forms of phosphorous and potassium in the soil solution. In comparison with the unfertilized control, the mobile phosphorous content

increased by 25.4 ppm (AG3) up to 65.4 ppm (AG3.2 Fe), and in case of mobile potassium by 32 ppm (AG3) up to 104 ppm (AG3.3 Zn).
As compared with the P and K fertilized control, the increase is not so high, except for the vitreous fertilizers containing Fe and Zn.
The modifications in the soil solution had a direct influence on the grapevine nutrition (table 4).

Table 4. Influence of the vitreous fertilizers on the grapevine nutrition (macro and micronutrients)

Treatment	N %	P %	K %	Ca %	Mg %	Fe ppm	Mn ppm	B ppm
Unfertilized control	2.50	0.22	1.79	3.16	0.27	95.0	42.1	52.3
P and K fertilized control	2.75	0.24	2.03	3.33	0.30	94.2	50.4	53.1
AG 3	2.63	0.26	1.99	3.50	0.37	97.5	68.7	64.5
AG 3.1 (B)	2.72	0.25	1.97	3.31	0.42	96.7	58.7	88.7
AG 3.2 (Fe)	2.69	0.25	1.83	3.29	0.35	108.4	56.6	60.4
AG 3.3 (Zn)	2.61	0.26	2.24	3.38	0.32	93.4	50.0	54.4
AG 3.4 (Mn)	2.70	0.24	1.96	3.18	0.36	92.5	76.6	66.4
AG 3.5 (Mo)	2.68	0.24	2.02	3.63	0.47	100.9	75.0	69.3

Table 5. Influence of the vitreous fertilizers on the grapevine fertility and productivity indexes Variety Merlot /5BB

Treatment	Cfa	Cfr	Ipa	Ipr
Unfertilized control	1.35	0.57	117	50
P and K fertilized control	1.39	0.97	145	99
AG 3	1.43	0.97	139	94
AG 3.1 (B)	1.31	0.88	137	86
AG 3.2 (Fe)	1.32	0.84	148	94
AG 3.3 (Zn)	1.53	1.08	130	92
AG 3.4 (Mn)	1.46	0.90	146	90
AG 3.5 (Mo)	1.52	0.98	141	91

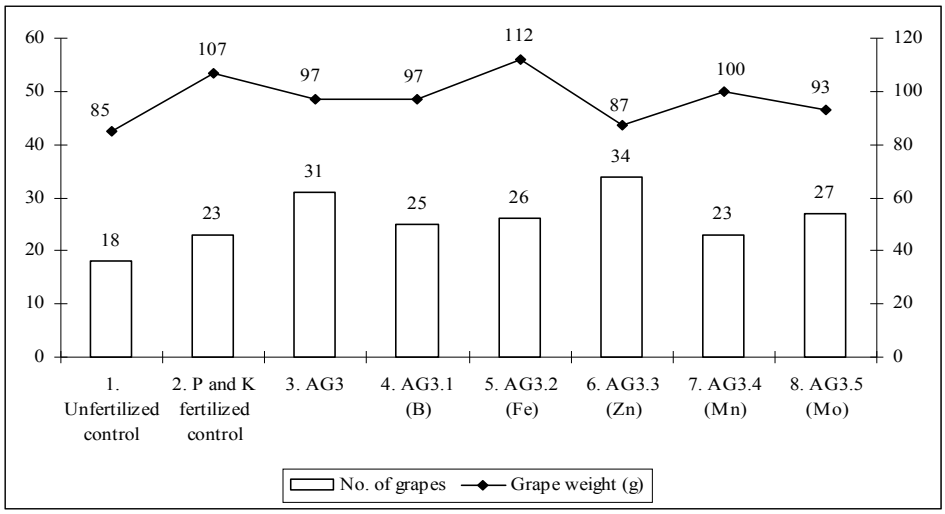

Figure 1. Influence of vitreous fertilizers on the number of grapes/trunk and on the weight of grapes

The experimental data have shown an evident influence of the application of vitreous fertilizers on the grapevine nutrition especially in case of K and Mg.
Concerning the influence of the vitreous fertilizers on the grapevine fertility and productivity indexes we can notice higher values for these indexes, especially for the relative fertility coefficient as compared with the value for the unfertilized control. The effect of the vitreous fertilizers was relatively similar to that of P and K fertilized treatment (table 5).

The same influence was noticed concerning the number of grapes/trunk and the weight of grapes (figure 1).
Regarding the influence of the vitreous fertilizer application on the grape yield, the variance analysis emphasized a positive effect as compared with the unfertilized control. It is also important to notice that the vitreous fertilizers induced a slightly positive difference concerning the grape yield as compared with the P and K fertilized control (table 6).

Table 6. Influence of the vitreous fertilizers on the grape yield
Variety Merlot /5BB

Treatment	Yield kg/trunk	Difference +/-	Signification	%
Unfertilized control	1.57	-		100
AG 3	2.89	+1.32	**	184
AG 3.1. (B)	2.34	+0.77		149
AG 3.2. (Fe)	2.81	+1.24	**	179
AG 3.3. (Zn)	2.86	+1.29	**	182
AG 3.4. (Mn)	2.22	+0.65		141
AG 3.5. (Mo)	2.68	+1.11	**	171
		DL 5% 0.80	DL 1% 1.08	DL 0.1% 1.45

Treatment	Yield kg/trunk	Difference +/-	Signification	%
P and K fertilized control	2.44	-		100
AG 3	2.89	+0.45		118
AG 3.1. (B)	2.34	-0.10		96
AG 3.2. (Fe)	2.81	+0.37		115
AG 3.3. (Zn)	2.86	+0.42		117
AG 3.4. (Mn)	2.22	-0.22		91
AG 3.5. (Mo)	2.68	+0.24		110
		DL 5% 0.82	DL 1% 1.11	DL 0.1% 1.49

Concerning the quality of the grapevine yield the experimental data have shown an evident influence of vitreous fertilizers only in case of anthocyanin content in grapes (figure 2).

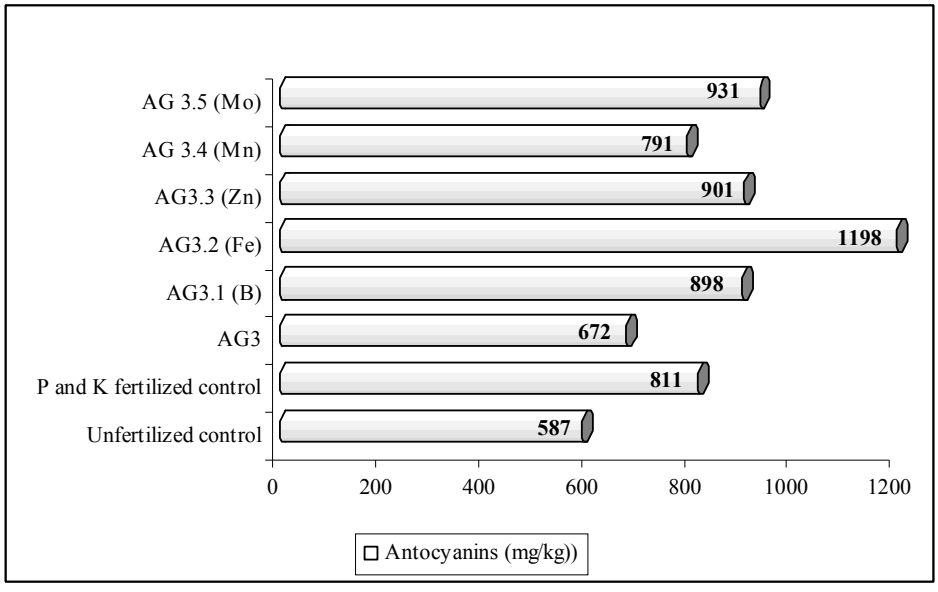

Figure 2. Influence of the vitreous fertilizers on the anthocyanin content in grapes (mg/kg)

The must sugar concentration depended to a lesser extent on the influence of the fertilizers applied (figure 3).

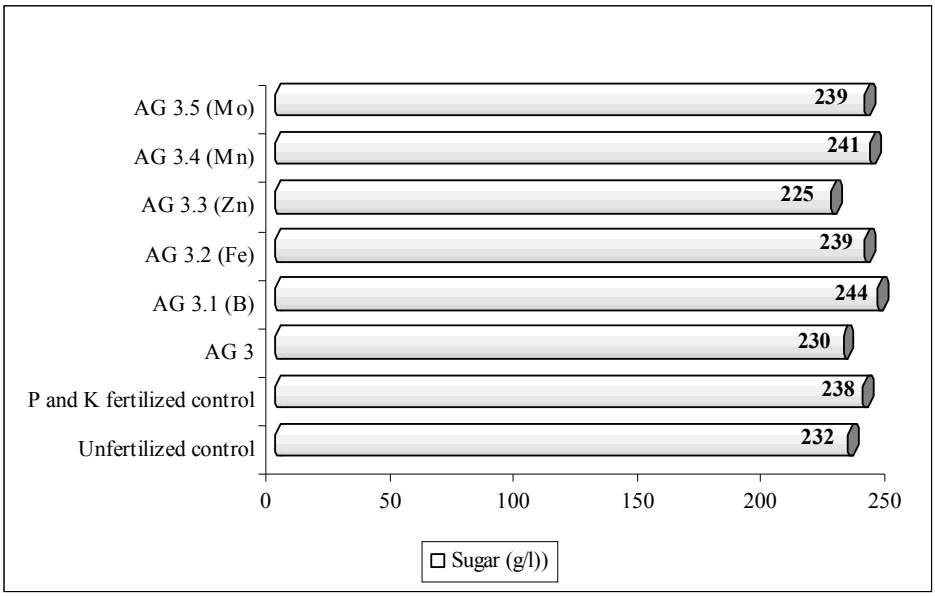

Figure 3. Influence of vitreous fertilizers on the sugar content of grapes (g/l)

The effect of the application of vitreous fertilizers on grape quality was noticed also in case of the quality of the wines obtained from these grapes (table 8).

Table 8. Influence of the vitreous fertilizers on the main quality parameters of Merlot wines

Treatment	Alchool degree % vol	Total acidity g/l tartric acid	Total extract g/l	Poly-phenols (IF)	Antho-cyanins mg/l	Tannins g/l	IC
Unfertilized control	13.0	6.60	26.8	41.5	255	1.56	6.89
P and K fertilized control	13.9	6.75	26.2	44.0	291	1.74	6.61
AG 3	13.6	5.93	24.8	38.3	202	1.40	5.28
AG 3.1 (B)	14.4	6.60	28.0	48.8	338	1.69	7.41
AG 3.2 (Fe)	14.4	6.53	26.2	41.8	314	1.70	6.83
AG 3.3 (Zn)	13.9	6.60	28.1	43.8	275	1.67	6.64
AG 3.4 (Mn)	14.1	6.68	27.9	41.8	298	1.76	7.06
AG 3.5 (Mo)	13.5	6.60	26.5	36.8	250	1.48	6.27

The experimental data have shown an increase of the alcoholic degree and of the wine content in polyphenols, anthocyanins and tannins in case of the fertilized treatments.
As compared to the P and K fertilized control, there is no evident difference in wine quality induced by the application of vitreous fertilizers.

4. CONCLUSIONS

- The use of vitreous fertilizers in grapevine fertilization induced an increase of macronutrients (P, K) in soil solution with a favorable effect on grapevine nutrition.
- The grapevine yield was positively influenced by the application of vitreous fertilizers. The presence of micronutrients in their composition (especially Fe, Zn and Mo) induced even a

greater yield as compared with the P and K fertilized control. The grape quality was also better, particularly in case of the anthocyanin content.

- The quality of the wines was improved by the application of vitreous fertilizers as compared to the unfertilized control. The alcoholic degree and the content in polyphenols, anthocyanins and tannins were higher, mainly in case of the vitreous fertilizers containing micronutrients in their composition.
- The use the vitreous fertilizers, the common ones or those containing micronutrients such as: B, Fe, Mn, Mo, Zn can be a real solution for the fertilization of vineyards, their effect being relatively similar to that induced by the use of the classical chemical fertilizers, the benefit consisting in a slow release over a long period of time of the nutrients from their composition, with positive effects in preventing environmental pollution.

5. REFERENCES

Bernaz Gh, Dejeu L (1999) Fertilizarea viilor şi întreţinerea solului în concepţie ecologică. Ed. Ceres Bucureşti

Condei Gh (1982) Fertilizarea rațională a solului din vii în condițiile crizei energetice actuale. Productia vegetală-Horticultura 9

Dejeu L (2010) Viticultură. Ed. Ceres Bucureşti

Fregoni M, Bavaresco L (2000) La concimazione della vite. Academia Italiană della Vite e del Vino:153-170

Fregoni M (2005) Viticoltura di Qualita. Ed. Phytoline, Affi