EFFECTS OF LIMING WITH HYDRATED LIME ON THE CONTENT OF IRON AND MANGANESE IN THE GRAPES

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Abstract

The effect of liming with $Ca(OH)_2$ in tree increasing rates of 1; 2,5 and 5 t/ha on the content of iron and manganese was studied in a two-year field experiment in the grapes of varieties Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Merlot, planted on Chromic luvisols. Immediately after harvest was studied the grapes of all varieties.

The content of iron in the fresh grapes was 3,28mg/kg, average of all variations and repetitions of the experiment.

The highest content of iron was found in the grapes of Cabernet Sauvignon, and the lowest - in Sauvignon Blanc. Proven differences between red and white varieties on the content of iron were not found. Liming as a single factor did not cause increasing modification of the content of iron in the fresh grapes, although established significant statistical differences between the variants limed with different rates.

Key words: *liming, wine grape varieties, iron, manganese*

1. INTRODUCTION

The extended modern notion of the soil acidity structure, includes in the composition of the elements, which have a toxicity in acidic soils, in addition to Al^{3+}, some more - manganese and iron. But, while the iron has too limited relevance to the formation of the harmful acidity in the soil zones of Europe, the interpretation of manganese phytotoxicity in acidic soils of temperate climate zone is widely spread.

According to Vozbudskaya (1964), Orlov (1985), Geering et al (2005), manganese in the soil was found, as water-soluble salts, exchangeable adsorbed in the composition of the soil sorption complex, insoluble oxides and hydroxides, and hardily soluble salts. When changing the redox conditions in the soil, part of Mn^{2+} gradually passes into an insoluble form and gradually mineralized to piroluzit, hausmanit, manganit or other complex oxides (Palaveev et al., 1974), and newly formed minerals are mostly in the form of iron-manganese nodules.

Once implemented, the process of oxidation secondary mineralization in the soil is irreversible and the included in the composition of new minerals manganese exit of the exchangeable balance in the soil (Mitev and Gurov, 1973, Nechev and Trendafilov, 1985).

The processes of desorption of manganese, its dynamics and final phase - enters the plants, depends to a very high degree of redox conditions in the soil, content, forms and oxidisability of the organic matter, the content of basic cations, and possibly all factors, pertaining to the condition and the activity of organomineral soil sorbent (Ilin, 1986, Kaurichev and Orlov, 1982, Mashev and Mirchev, 1989, Mitev and Gurov, 1973).

Complex dynamics of manganese in the system soil-plant is the subject of discussion, both, in the aspect Mn to be considered as a nutrient microelement with certain functions in plant biology (Enikov and Benevski, 1984, Stanchev at al, 1982, Troeh, 1993, Shkolynik, 1974), and in terms of its toxicity in acidic soils (Dong et al., 1999, Matschonati and Falkengren-Grerup, 2000, Daniel et al., 2007, Porter et al., 2004, Shamshuddin et al., 2010, Silber et al., 2008, Tyler and Olsson, 2001, Palaveev at al., 1970, 1971, 1972, 1974).

2. MATERIAL AND METHODS

The studies have been conducted in a two-year field experiment in vineyards in the Mezek village, Svilengrad Municipality. The main soil differences within the studied object are Chromi-eutric cambisols and Chromic luvisols with different differentiated soil profile.

The scheme of the experience is the method of long plots by Shanin, and in the distribution of the variants is included control variant without fertilization and liming, variant without liming, but combined nitrogen, phosphorus and potassium fertilization, and three increasing rates of liming with hydrated lime - 1, 2,5 and 5 t/ha.

Table 1. Applied amounts of chemical ameliorants and fertilizers in the variants on the field experiment

Variant	Variety	Rate hydrated lime t/ha	Rate N kg/ha	Rate P_2O_5 t/ha	Rate K_2O kg/ha
Control variant	Chardonnay	0	0	0	0
	Sauvignon Blanc	0	0	0	0
	Merlot	0	0	0	0
	Cabernet Sauvignon	0	0	0	0
Fertilization - N,P,K	Chardonnay	0	140	1	600
	Sauvignon Blanc	0	140	1	600
	Merlot	0	140	1	600
	Cabernet Sauvignon	0	140	1	600
Hydrated lime	Chardonnay	1	140	1	600
		2.5	140	1	600
		5.0	140	1	600
	Sauvignon Blanc	1	140	1	600
		2.5	140	1	600
		5.0	140	1	600
	Merlot	1	140	1	600
		2.5	140	1	600
		5.0	140	1	600
	Cabernet Sauvignon	1	140	1	600
		2.5	140	1	600
		5.0	140	1	600

The distribution of the experiment variants is shown in Table 1.

The content of CaO in the used in this study hydrated lime, determined after reacting the starting material with HCl and a subsequent titration with NaOH, at bromthymolblau indicator was 94%. Each of the variants was displayed in three repetitions.

The experiment was set after the end of the third vegetation period. All included varieties in the study were planted on pad Berlandieri X Riparia, selection Oppenheim 4 (SO4). The ameliorants were applied in the period August - September. One month after liming were applied phosphorus and potassium fertilizers, respectively as triple superphosphate and potassium sulphate, and nitrogen fertilizer as NH_4NO_3 was applied in February, before the beginning of the next vegetation period.

The grapes of the four investigated varieties, was studied immediately after harvest in the technological maturity, together with the massive harvest of each variety in the vineyards. Harvested grapes, was separated from the stalks, and the grapes were prepared for analysis and analyzed to determine the content of iron and manganese, atomic-absorption after dry ashing in the grapes of wine grape varieties.

3. RESULTS AND DISCUSSION

In a two-year field experiment was studied the effect of liming on the content of iron and manganese in the grapes of four varieties - Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Merlot.

The content of iron in the fresh grapes was 3,28mg/kg, average of all variations and repetitions of the experiment. Relatively highest iron content was found in the grapes of Cabernet Sauvignon, and the lowest - in Sauvignon Blanc. Proven general differences on the content of iron between red and white varieties were not found.

Liming as a single factor did not cause gradual modification of the iron content in the fresh grapes, although established significant statistical differences between the variations, which were limed with various rates. For example, the highest iron content was found in the variation, which the lime was applied in rate of 2,5 kg/ha, while in the control variants and in the variants with higher and lower rates, the iron content was lower. Similar changes in the composition of the grape in regard to the content of manganese.

Generally, these two elements reserved relatively equal proportions among themselves in the grapes of all studied varieties and variants of liming.

The correlation in the content of this two elements in the grape was better expressed in the cases, where was found relatively higher concentrations in the contents of Fe and Mn in the composition of the grape.

Differences in the established content of iron and manganese in the two consecutive years of the study was not found. According to Trendafilov and Valcheva (2012), the tendency in the assimilation of manganese and iron differ somewhat from those established on the absorption of main nutritional macroelements.

The vine has very high tolerance to high manganese concentrations. It is believed, however, that the acid soil conditions are only one of many factors, that influence the assimilation of manganese from the vines.

The assimilation of manganese by plants depends simultaneously on its solubility (which is a function of pH and other factors), and also directly from pH of the soil in the root zone.

In the literature, there are very different opinions for the average content of Mn in the soil and its content in the plant biomass. Some authors attribute the differences in content of manganese to the conditions of the local growth of vineyards, in the belief, that the differences in the content of manganese in the soil are not as significant as the overall condition of the plant.

This was probably due to higher correlation between the assimilation of manganese and iron with the acid soil conditions.

The data for the content of iron and manganese in the fresh grapes is shown in Table 2.

Table 2. Contents of Fe and Mn [mg/kg] grape in varieties Chardonnay, Sauvignon Blanc, Cabernet Sauvignon and Merlot, depends on the liming rate with hydrated lime

Year	Direction of cultivation	Variety	hydrated lime (t/ha)	Fe [mg/kg]	Mn [mg/kg]
1	2	3	4	5	6
1	White	Chardonnay		3.87	3.43
			1	2.30	2.30
			2,5	4.00	6.20
			5	3.40	3.40
		Sauvignon Blanc		2.93	4.20
			1	1.20	2.60
			2,5	4.30	6.90
			5	1.70	2.60
	Red	Cabernet Sauvignon		3.70	1.60
			1	2.70	2.10
			2,5	5.00	3.60
			5	4.40	1.90
		Merlot		3.10	2.00
			1	2.50	1.30
			2,5	3.40	1.50
			5	4.40	1.50
2	White	Chardonnay		3.73	3.47
			1	2.20	2.20
			2,5	3.80	5.90
			5	3.10	3.30
		Sauvignon Blanc		2.73	4.03
			1	1.20	2.50
			2,5	4.20	6.40
			5	1.60	2.40
	Red	Cabernet Sauvignon		3.63	1.50
			1	2.70	2.00
			2,5	4.70	3.50
			5	4.40	1.80
		Merlot		3.03	1.97
			1	2.50	1.30
			2,5	3.40	1.50
			5	4.10	1.40

4. CONCLUSION

The highest content of iron and manganese was found in the lowest applied ameliorative rate of 2,5 t/ha in the grapes of the four studied varieties. Particular importance for the assimilation of those elements has their content in the soil, and their ratio with Ca in exchangeable form.

The highest content of iron was found in the grapes of Cabernet Sauvignon, and the lowest - in Sauvignon Blanc. Proven differences between red and white varieties on the content of iron was not found. Liming as a single factor did not cause increasing modification of the content of iron in the fresh grapes, although established significant statistical differences between the variants limed with different rates. Both elements reserved approximately the same correlation ratio during both investigation years.

The correlation in the content of this two elements in the grape was better expressed in the cases, where was found relatively higher concentrations in the contents of Fe and Mn in the composition of the grape.

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