

INFLUENCE OF LIMING WITH $\text{Ca}(\text{OH})_2$ AND STOCKPILING FERTILIZATION ON THE NITROGEN, PHOSPHORUS AND POTASSIUM CONTENT IN THE GRAPE OF WINE GRAPE VARIETIES

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Abstract

In condition of combined field experiment was studied the influence of liming with $\text{Ca}(\text{OH})_2$ at rates of 1.0, 2.5 and 5.0 t/ha on the input of nitrogen, phosphorus and potassium in the grapes of fertility vines from varieties Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Merlot planted on Chromic luvisol. Samples were collected in two consecutive years. At the variants with liming rates of 2.5 and 5.0 t/ha hydrated lime was found the average higher nitrogen content compared to the control variant, but the excess was more significant only at the rate of 2.5 t/ha, average for all participating varieties. Highest nitrogen content was found in the grapes of the varieties Chardonnay and Merlot, and the lowest - in Cabernet Sauvignon. Differences between the varieties for red and white wines were statistically proven regarding to the nitrogen content in the grapes. In the red wine varieties was found average about 70% of the nitrogen content in the white varieties. Liming with rates of 1.0 and 2.5 t/ha leads to logical and proven toward variation in the repeats increase in the concentration of potassium in the foliage - respectively to 0.238% average for the rate of 1.0 t/ha and 0.275% for the rate of 2.5 t/ha. When applied the rate of 5.0 t/ha lime material was found reduction of the potassium content and below the level of the control variant - up to 0.200%. The grapes in the white varieties contain proven more potassium compared to the red varieties, as the highest was average amount of potassium in the grapes of variety Sauvignon Blanc.

Key words: liming, nitrogen, phosphorus, potassium, wine grape varieties.

INTRODUCTION

The variety of soil conditions in Bulgaria is large and in terms of opportunities for wine viticulture in recent years was formed specific areas for production of quality wines, which according to the methodology for determination of areas for their production (Mihalev Trendafilov, 2005) should cover certain requirements regarding to the location of vineyards. In this sense, the location determines the specificity, and the specificity is due to the advantages and disadvantages of the region, including its soils. In this terms of ameliorative influences on the soil conditions could be accepted insofar as no change the specific and proven for some wine region advantages of the landscape.

The influence of soil acidity on the varieties of *V.vivifera*, in the cultivation technology of grafted and rooted vines differentiated once by interactions between the root of the pad and the soil and the second time - the interaction

between the pad and cultural vine (Kaserer et al., 1996).

Sanjun Gu (2010) summarizes 19 general types interactions between these general three elements of the system soil-pad-vine, which influence on the quantity and quality of the final product and it should be in mind, that each of them is a complex indicator and depends on the specific environmental conditions. This indefiniteness of the system location - wine vineyards was the reason for the emergence and development of a discussion concept for vineyard terroir. Much of the publications on the topic, although detailed to describe the physiographic characteristic on more or less known vine terroirs, they have not indicated interpretation of the link between the quality of the terroir and the quality of grapes from wine vineyards of the respective area, and did not answer the question of with which own qualities the terroir gives specifics of wine vineyards, cultivated there and why is that.

In this context, we believe that the liming of acidic soils in the vineyard areas should be

limited to detoxify of harmful in acidic soils concentrations of easily mobile exchangeable aluminium, hydrogen and manganese, but should not be allowed to completely change soil-chemical environment.

The aim of this study was to research the influence of liming with $\text{Ca}(\text{OH})_2$ on the content of nitrogen, phosphorus and potassium in the grapes of fertility vines from varieties Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Merlot planted on Chromic luvisol.

MATERIALS AND METHODS

The experiment was performed for two years period in already existing vineyards, planted on acidic soils, which were not liming before planting.

Each of the variants was displayed in three repetitions. The distribution of the variants of the experiment has shown in Table 1. The vineyard was planted in intercrop distances 2.20 m and interline distance between the vines – 1.10 m. 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 (SO_4). The ameliorant, phosphorus and potassium fertilizers were applied in the period August - September. One month after liming were applied phosphorus and potassium fertilizers in the form respectively of triple superphosphate and potassium sulphate and nitrogen fertilizer in the form of NH_4NO_3 was applied in February, before the beginning of the next vegetation period.

The grapes from the four varieties, was studied immediately after harvest in the technological maturity, together with the massive harvest of each variety in the vineyards, which developed field lime experiment.

Harvested grapes, was separated from the stalks and grapes were prepared for analysis and analyzed to determine the content of nitrogen, phosphorus and potassium. The measurements were carried out in two consecutive years coincide with the periods of measuring of indicators in foliage.

The samples of plant material were analyzed after wet burn by Keldal method. Nitrogen was

determined by distillation on apparatus of Parnas-Vagner, phosphorus - colorimetrically on molybdate-vanadate method, potassium - by flame photometer (BDS 11374/86).

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

RESULTS AND DISCUSSIONS

The experiment was performed in already existing vineyards, planted on acidic soils, which were not liming before planting. The main aim of the study was to research the influence of liming in increasing doses and the mineral fertilization on the content of main nutrient macro elements - nitrogen, phosphorus and potassium in the grapes of four wine varieties vines - Chardonnay, Sauvignon Blanc, Merlot and Cabernet Sauvignon.

Table 2 shown the contents of nitrogen, phosphorus and potassium in the grapes of the four varieties, depends on the rate of liming with hydrated lime.

In the variants with liming rates of 2.5 and 5.0 t/ha hydrated lime was found average higher nitrogen content compared to the control variant, but the excess was significant only at the rate of 2.5 t/ha, average for all participating varieties. The ameliorant even in relatively lower rates had amelioration effects by

neutralizing easily mobile exchangeable positions and less by modifying of exchangeable reserve of the bases. The positional inaccessibility and spatial heterogeneity of the ameliorant was sufficiently overcome for a period of about two years, from the date of liming and simultaneously with this starts fast process of leaching of the ameliorant in deeper layers. From a technological view point it can be assumed, that depth of layer, for which should count the rates for chemical-amelioration effect under the described conditions for chemical amelioration of acidic soils under existing plantations was 50 cm from the soil surface (Valcheva and Trendafilov, 2011). The stockpiling fertilization with phosphorus and potassium had weak effect on the neutralization of soil acidity, as caused weak neutralization of soil sorption positions occupied by exchange hydrogen.

The neutralization effect was manifested in weakly buffered soils or in less buffer zone of the profile of acid and unsaturated differentiated soils. In the presence of relatively weak buffering of the sorption complex, the buffering potential, associated with the transformation of the phosphate and the activity of potassium from the fertilizers causes a reduction in the equilibrium concentrations of hydrogen in exchangeable form. The mineral fertilization with the main nutrient elements caused an increase in nitrogen content in the grapes which occurs independently from the variety and the direction of cultivation (Valcheva et al., 2012). Highest nitrogen content was found in the grapes of Sauvignon Blanc, Chardonnay and Merlot and lowest in Cabernet Sauvignon.

The differences between the varieties for red and white wines were statistically proven as regards of the nitrogen content of the grapes. In the red wine varieties was found average about 70% lower nitrogen content compared to the white wine varieties. It is quite possible this difference to be due to the late harvest of the red wine varieties, when the active metabolism of the cells in the tissue of the grape mass had completely finished, while the white wine varieties harvest in phase of still active vegetation.

Table 2. Content of nitrogen, phosphorus and potassium [%] in grape from varieties Chardonnay, Sauvignon Blanc, Merlot and Cabernet Sauvignon, depends on the liming rate with hydrated lime

Year	Direction of cultivation	Variety	Rate hydrated lime t/ha	N (%)	P (%)	K (%)
1	2	3	4	5	6	7
1	White	Chardonnay	1	0.17	0.013	0.27
			2.5	0.10	0.020	0.22
			5.0	0.20	0.010	0.23
			5.0	0.20	0.010	0.22
		Sauvignon Blanc	1	0.20	0.013	0.27
			2.5	0.20	0.010	0.24
	Red	Cabernet Sauvignon	1	0.13	0.010	0.22
			2.5	0.10	0.010	0.22
			5.0	0.10	0.010	0.22
			5.0	0.10	0.010	0.23
		Merlot	1	0.17	0.010	0.17
			2.5	0.20	0.010	0.22
2	White	Chardonnay	1	0.17	0.013	0.23
			2.5	0.10	0.020	0.22
			5.0	0.20	0.010	0.23
			5.0	0.20	0.010	0.22
		Sauvignon Blanc	1	0.20	0.013	0.27
			2.5	0.50	0.020	0.24
	Red	Cabernet Sauvignon	1	0.13	0.010	0.22
			2.5	0.10	0.010	0.22
			5.0	0.10	0.010	0.23
			5.0	0.10	0.010	0.22
		Merlot	1	0.17	0.010	0.17
			2.5	0.20	0.010	0.22
2	Red	Cabernet Sauvignon	1	0.13	0.010	0.22
			2.5	0.10	0.010	0.22
			5.0	0.10	0.010	0.23
			5.0	0.10	0.010	0.22
		Merlot	1	0.17	0.010	0.17
			2.5	0.20	0.010	0.22
2	White	Chardonnay	1	0.17	0.013	0.23
			2.5	0.10	0.020	0.22
			5.0	0.20	0.010	0.23
			5.0	0.20	0.010	0.22
		Sauvignon Blanc	1	0.20	0.013	0.27
			2.5	0.50	0.020	0.24
Red	Cabernet Sauvignon	1	0.13	0.010	0.22	
		2.5	0.10	0.010	0.22	
		5.0	0.10	0.010	0.23	
		5.0	0.10	0.010	0.22	
	Merlot	1	0.17	0.010	0.17	
		2.5	0.20	0.010	0.22	

Weak and unproven statistical tendency for excess of phosphorus content, compared to the control variant was observed in variants, with applied lime rates of 1.0 and 2.5 t/ha lime material, while the phosphorus content in the variant with the highest applied rate was lower compared to the control variant.

The varietal differences manifested and with regard to the phosphorus content in the grapes. The white varieties contain average with 30% higher amount of phosphorus in the grapes, compared to the red varieties, and this tendency

was proven in the volume of the entire sample characterized the average of the two experimental years.

The differences between the amount of contained phosphorus in the grapes in the two consecutive years of measurement was not found.

Potassium content in the grapes, average for the entire sample of all varieties and variants of liming was 0.229%. The liming with rates of 1.0 and 2.50 t/ha leads to logical and proven, compared to variation in the repeats increase in the concentration of potassium in the fresh mass of the grapes, respectively to 0.238% average for the rate of 1.0 t/ha and to 0.275% for the rate of 2.50 t/ha. When applied the rate of 5.0 t/ha lime material was found decrease of the potassium content and below the level of the control variant to 0.200%. A similar tendency was found and in regard to the assimilation of phosphorus, however, here it was more pronounced and statistically proven. The grapes in the white varieties contain proven more potassium compared to the red varieties, as highest was average amount of potassium in the grapes of the variety Sauvignon Blanc. Proven difference between the potassium content of the grapes in the two consecutive years of measurement of the composition of the grape mass was not found.

CONCLUSIONS

As a result of the study was found highest nitrogen content in the grapes of varieties Sauvignon Blanc, Chardonnay and Merlot, and the lowest in Cabernet Sauvignon.

The white varieties contain with 30% higher amount of phosphorus in the grapes compared to the red varieties, as this tendency was proven in the volume of the entire sample. The grapes in the white varieties contain proven more potassium compared to the red varieties, as highest was the average amount of potassium in the grapes of the variety Sauvignon Blanc.

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