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INFLUENCE OF LIMING WITH $Ca(OH)_2$ ON THE CALCIUM AND MAGNESIUM 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 $Ca(OH)_2$ at rates of 1.0, 2.5 and 5.0 t/ha on the input of calcium and magnesium 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. In the first year of the study was not found statistically proven variation of the Ca content in the composition of the fresh grape mass. The available Ca amount in grapes in ameliorative lime rate of 5.0 t/ha was lower compared to that what was found for the lower ameliorative lime doses. About magnesium was found statistically proven exceed at the variants with liming, compared to the variants without liming. Overall white varieties during the first year assimilated more Ca amount compared to the red varieties. According to Mg this difference was insignificant. The differences between limed varieties and the control variant in the second year of the study according to the Ca content in the grape were statistically proven at level of probability 95%.

Key words*: liming, calcium, magnesium, wine grape varieties.*

INTRODUCTION

The acidity in the soil usually occurs simultaneously with more or less pronounced deficiency of calcium or magnesium, or both elements in exchangeable form in the soil. Calcium is the main antagonist on the exchangeable forms of aluminium, hydrogen and most of the metal ions in the composition of the soil sorption complex. In strongly acidic and weakly buffered soils, Ca may be in deficit as nutrient element in the plants. So strong calcium deficiency is very rare, but should be considered when interpreting the data for Ca content in the soil. This is determined by the important physiology-biochemical functions of Ca, mainly related with the process of photosynthesis, by regulating the state and the electoral permeability of the plasma membranes with neutralizing and buffering reactions of the cytoplasm (Kadrev and Peev, 1980). For probable deficit of Ca, as the nutrient element was reported in soils, contain exchangeable Ca in concentration less than 2 meq/100 g (Palaveev and Totev, 1970).

In a study of the properties of different pads and their suitability for specific soil conditions, Himelrick (1991) concluded, that independently of the tolerance of the vine to soils with a wide range of pH (4.05-6.05), pronounced acidity depresses the development mainly of the root system. The author was found a high resistance to acid reaction of the hybrids of *V. labrusca* of pads SO_4, 3,309 Couderc of *V. vinifera*, and varieties Riesling and Chardonnay were most intolerant. The lower tolerance of the white varieties to acidic soil reaction, however, was not associated with different rates of absorption elements from theme, including Ca. All this experimental data were insufficient to formulate criteria for degree of injuriousness of the acidity and degree of lime necessity for vineyards, especially taking into account the combination pad - variety directions (white and red wine varieties) - variety - branches direction (Group A, B and C) - a branch of the variety.

There is a tendency, according to which the application of chemical ameliorants in acidic soils often leads to contradictory and sometimes to negative results, contrary to ameliorants expectations, as a result of an imbalance of the nutrient elements in the soils with liming and account of the specific requirements of the meliorated plants.

The planting practice of large part from the modern plantations of vineyards in the country on genetically acid soils, the proven in recent

years adverse effects of soil acidity for the quality of wine grapes (Soyer et al., 1995) and higher requirements of the modern and most often introduced clonally-pads combinations to soil quality (Robredo et al., 1991) renewed the topicality of this task, and its technological complexity cause the necessity of testing new chemical liming ameliorants.

The use of hydrated lime and its high solubility is useful, because of the necessity from overcome the position inaccessibility of calcium contained ameliorants in the active root zone. The amelioration of acid soils in terms of existing durable plantations was technologically possible and causes a response in the plant at the implementation of compliance with the special conditions for conduction of chemical amelioration (Valcheva and Trendafilov, 2011).

In this sense, the aim of the current work was to research the influence of the hydrated lime in increasing rates over the acid-alkaline balance of Chromic luvisol and to determine the influence of liming on calcium and magnesium content in the grapes of four major wine varieties - Sauvignon Blanc, Chardonnay, Cabernet Sauvignon and Merlot.

MATERIALS AND METHODS

The interpreted results in this study were obtained as a result of field experiment with fertilization and liming of vineyards in fruit-bearing, planted over unsaturated Chromic luvisol in village of Mezek, Svilengrad municipality.

The experiment scheme was over the method of the long plots (Shanin, 1965), as in the allocation of the variants was included control variant without fertilization and liming, variant without liming, but with combined nitrogen, phosphorus and potassium fertilization and three increasing liming rates with hydrated lime – 1.0, 2.5 and 5.0 t/ha. The experiment was displayed for two years period, as until the beginning of the experiment this plantation was not liming and fertilization with mineral fertilizers neither as a stockpiling nor as current fertilization. This gave us reason to apply phosphorus and potassium fertilizers as rate of stockpiling fertilization - respectively 1.0 t/ha and 600 kg/ha active substance and nitrogen annually by 140 kg/ha active substance in the form of ammonium nitrate.

Each of the variants was displayed in three repetitions. The vineyard was planted in intercrop distances 2.20 m and interlinear 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 Openheim 4 (SO_4), in vegetation experiment this pad shown good tolerance to deficit and excess of calcium and magnesium in the nutrient solution (Valcheva and Trendafilov, 2012).

The ameliorants, 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.

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, in which was 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, coinciding with the periods of measuring of the indicators in foliage.

The content of calcium and magnesium in the grapes was determinate atomic absorption after dry aching (BDS EN 14082/03).

RESULTS AND DISCUSSIONS

The data for the content of calcium and magnesium in the grapes of the varieties, which were included in the study, were presented graphically in Figure 1 and Figure 2. The amendment of calcium and magnesium content in the fresh mass of the grapes depends on calcium content in the soil and it was a major component, which directly were influenced by liming.

In the first year of the study was not found statistically proven change of Ca content in the

composition of fresh grape mass. The average Ca content in the variants without liming was 60 mg/kg - value, which was considered as low. In some of the variants and especially in those which were used lime rates of 1.0 and 2.5 t/ha hydrated lime was observed increase compared to the control variant, but under high variation in the repeats, and hence a high level of error.

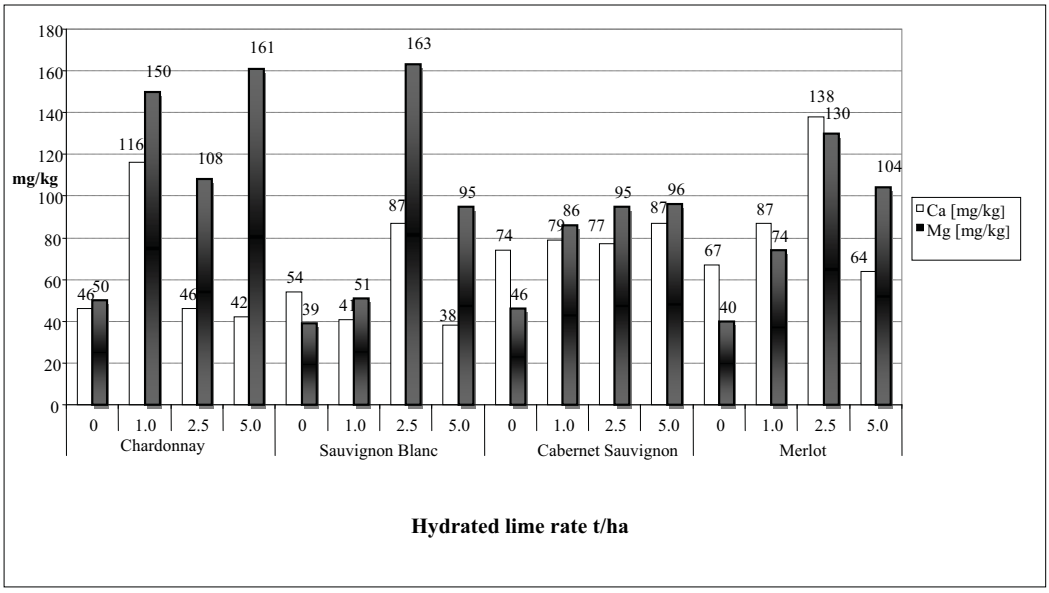

Figure 1. Contents of Ca and Mg in the grapes from varieties Chardonnay, Sauvignon Blanc, Merlot and Cabernet Sauvignon - first year of field experiment with lime

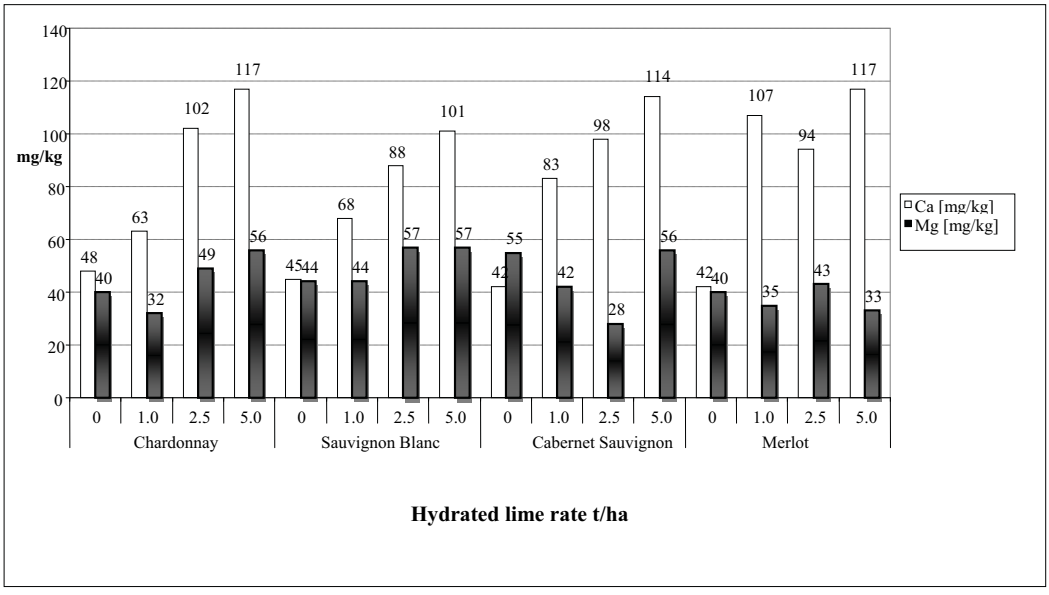

Figure 2. Contents of Ca and Mg in the grapes from varieties Chardonnay, Sauvignon Blanc, Merlot and Cabernet Sauvignon - second year of field experiment with lime

In the variants, in which were used rate of 5.0 t/ha lime material in some cases - for example, in Cabernet Sauvignon, Chardonnay and Merlot the available Ca amount in the grapes at ameliorative lime rate of 5.0 t/ha was lower compared to which was found for the lower ameliorative lime rates.

About magnesium was found statistically proven exceed at the variants with liming, compared to the variants without liming, but also at high level of dispersion of the values for the obtained results. Proven varietal differences in the content of Ca and Mg also were not found. The white varieties generally during the first year absorbed a larger amount of Ca, compared to the red varieties. About Mg this difference was insignificant.

During the second year of the conducted measurements the average Ca content in the control variants without liming was 44.6 mg/kg and probably the difference between the Ca content in the two consecutive years reflects the natural variation of the content of this element in unsaturated soils and without ameliorative interventions. It is clear therefore that the factor "liming" is superimposed on this variability, which from one side illustrates and deficit of the element Ca in the system soil-plant in the soil conditions at the lime experiment. In regard to Mg this variability in the two consecutive years of the experiment was not found.

The differences between the variants with liming and the control variant during the second year of the study in regard to the content of Ca in the grapes were statistically proven at a level of probability 95%. The value of Ca in the variants with liming rate of 1.0 t/ha was 37.95±24.12 mg/kg, in the variant with liming rate of 2.50 t/ha was 95.35±24.12 mg/kg and the variants with liming rate of 5.0 t/ha was 112.37±22.26 mg/kg. Independently from the relatively high values of dispersion in the said replications shows, that in condition of deficit of bases in the soil, apply of Ca containing ameliorants in the soil allows the plant to realize its ambition to reach the equilibrium concentrations of Ca in the reproductive parts. Firmly the ascending character of the dependence, reflecting the content of Ca in the grapes, as a function of lime rate shown, that in terms of the requirements of the plant until the second year after the experiment was set this equilibrium concentration has not been reached yet. This was in agreement with the data from the literature sources, according to which the average equilibrium content of Ca was about 20 mg/kg (Simon, 1978).

The liming with calcium containing ameliorants did not have proven effect on Mg content in the grapes, but in some of the varieties (Cabernet Sauvignon) shown tendency for reduction of its average level when liming.

The varietal differences in the content of Ca and Mg in the composition of the grapes were inessential in all varietal samples and in the groups "White" and "Red" wine varieties. This allows us to deduce the hypothesis that the composition of plant biomass on the vine in most was genotypic deterministic and secondly depends on the complex of growing conditions. The presence of acid and especially acidic and weakly buffer in acidic soils, for which is typical low Ca^{2+} content in the sorption complex determine strong deficit, who compensate by advantage in its partial or full compensation through ameliorative interventions. To achieve it, however it takes time more than one growing vegetation. It is possible only after attainment of equilibrium concentrations of the ions in the plant cell, the plant can stably respond and with a change in its technological characterizations, as they have a lower biological priority.

CONCLUSIONS

The liming in a field experiment affects the composition of the grape production and leads to a positive variation of calcium content in the composition of the grapes. Probably this is not durable tendency, which found most clearly in the period immediately after ameliorative intervention, when plants absorb and redistribute relatively larger amounts of calcium from ameliorant before realized its full interaction with the soil.

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