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LEAF MACRONUTRIENT COMPOSITION OF GRAPES IN SOUTH PLAIN HUNGARIAN VINEYARDS

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ABSTRACT

In our study analysis of samples of vine leaves taken in the different phases of vegetation was carried out in three years, 2010-2012. Our analysis confirmed the translocation of nutrient elements in varying degrees. Laboratory tests were made on about eight thousand leaf samples in our laboratory (Soil and Plant Testing Laboratory of Faculty of Horticulture, Kecskemét College). The results of sample tests, largely arriving from the Southern Hungarian plain region, mainly Bács-Kiskun county, showed that the level of the main nutrient elements from bloom to the completion of maturation tends to decrease. In the case of phosphorus, a continuous slow decline was shown, while N and K varied according to a curve; increase in the beginning of ripening and significant decrease afterwards. Changing in the ratios of some main nutrients (N/K and K/Mg) was also shown. Low level of potassium and phosphorus was observed in about one fifth of the samples, so increase in P and K fertilization may be proposed.

Keywords: leaf sample, macro nutrients, analysis, grape

INTRODUCTION

Grape is not designed specifically as a high nutrient demanding plant. Apart from the very extreme soils (highly acidic, saline, airless meadow, bog), it is able to grow in a wide range of soils. As a sugar accumulating plant, however, its potassium demand is significant. Potassium deficiency can be caused by the potassium-poor sandy soil, inhibited uptake due to the antagonism of the Mg and Ca, drought or tending to dry weather (SZŐKE, 2006). Magnesium is also an important nutrient; but the lack of this in plantation is rare. Magnesium deficiency may develop on loose soils, without structure or as a consequence of the high degree of soil acidification. Demand for nitrogen is not great, but the N deficiency and excess weight can also be harmful (SCHREINER, 2006; NÉMETH, 2006). The importance of boron among the micro nutrients can be highlighted, however, in some areas (Balaton Uplands) iron deficiency can cause distraction.

The absence of most nutrients may be followed by leaf analysis. On the basis of the result of the leaf blade investigation we may conclude the uptake of nutrients, as well as the nutrient supply disturbances. In addition to the soil test results it can be used to determine the nutrient needs of grapes. As prescribed by regulation relating to sampling, leaf samples should be collected in the opposite to the first cluster; two optional dates are blooming and ripening (harvest).

According to nutrient uptake dynamics in general, the uptake of the main nutrient elements are the largest from budbreak to veraison, and during the ripening process continues to decrease. The exception to this is magnesium, because the level of it is almost constant in the full season (SZŐKE, 1995). The uptake of the micronutrients compared to macroelements is a little later in the time, with a maximum reached at the first phase of

ripening. Each level and relative ratio of some nutrient elements may cause adverse effects, so the critical values are worded in generally accepted guidelines (KOVÁCSNÉ, 1981).
Our tests determined the level of the most important macroelements by grape leaf analysis, and the results were processed according to the different stages of the growing season. On the other hand, a brief comparison was made in the 2010-2012 period of the possible effect of the different weather conditions. Our laboratory studies were made on the basis of samples from more than a thousand clients.

MATERIAL AND METHOD

The collection of samples from the plants was carried out by the farmers, in the management period between 1. May and 15. September of 2010, 2011 and 2012. Grape plantations were located in southern plain region of the country, mainly in county Bács-Kiskun. We have developed test results of 2580, 2220 and 3050 grape leaf samples in 2010, 2011 and 2012, respectively. According to the regulation of the ministry on agro environmental management program 61/2009 (V. 14)/, characteristic leaves opposite the first cluster should be collected for testing in the phase of bloom or ripening, once a year, on a compulsory basis. The taking and handling of plant samples and the scope of the tests was made taking into account relevant legislation.
Analytical testing methods were made in the Soil and Plant Testing Laboratory of Faculty of Horticulture (Kecskemét College). Our laboratory uses standard methods involved in accreditation certificate (NAT-1-1548/2011).
Petiole was removed, and then leaf blade samples were thoroughly washed. Leaf samples were dried at 70 °C. The air-dry samples were thoroughly minced. For elemental studies powdered samples were digested in a microwave device by means of concentrated nitric acid and hydrogen peroxide (Milestone Ethos Plus). Main macro element content was measured by optical emission spectrometer (ICP-AES method). Nitrogen content in leaf blades was determined using the Kjeldahl method after sulphuric acid digestion (FOSS Kjeltec 2300). Macro element (N, P, K, Ca, Mg, Na) contents were calculated in m/m% dry matter.
The required tests according to the regulation include measurement of the N, P, K, Ca, Mg content. In nearly 20% of the samples, micronutrient contents were also tested however, the results of these are evaluated in our other study.
The results of analysis were divided into 9 sections according to the phenological phases (from completion of the maturation to total ripening), the length of these periods was two weeks on average. The nutrient contents were shown graphically in the 3 consecutive years and the frequency of deficiency symptoms was also evaluated. The ratio of N to K and K/Mg ratio were also calculated. For estimating changes in the concentration of the main nutrients Student's two-pair t-probe was applied.

RESULTS

Main macroelements in leaves were N and Ca, followed by K, Mg and P. At different stages of the phenological phases (1-9) nitrogen, phosphorus, potassium, levels of the grape leaf samples in three consecutive years, are illustrated in *Figures 1-3*.

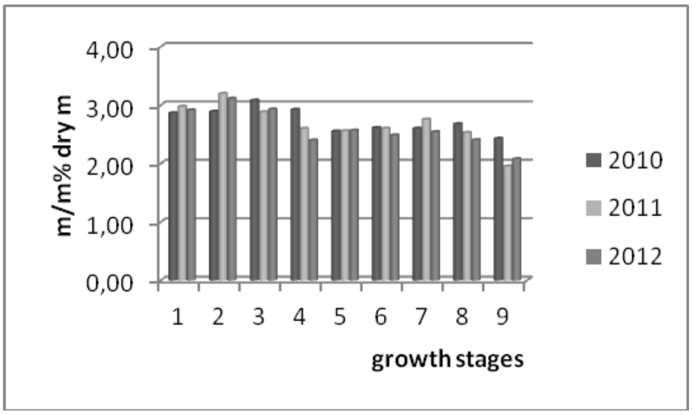

Figure 1. Changes in nitrogen content of grape leaf blades in different growth stages (1-9) from bloom to total ripening in 2010, 2011 and 2012

Nitrogen content in leaves increased significantly after blooming to the beginning of ripening (to stage 2 or 3), whereas it decreased thereafter ($p<0.001$).

As for potassium content of grape leaves, there was a tendency to increase after bloom, the highest level was reached at growth stage 4 in every year, and it sharply decreased afterwards (*Figure 2*).

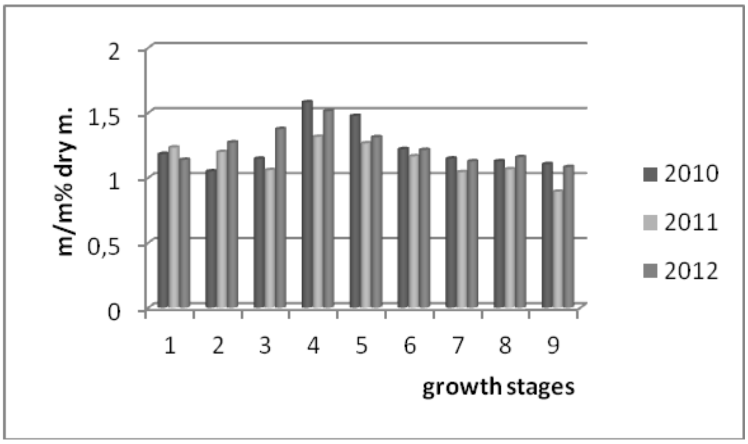

Figure 2. Changes in potassium level (m/m% dry matter) in grape leaves in different growth stages (1-9)

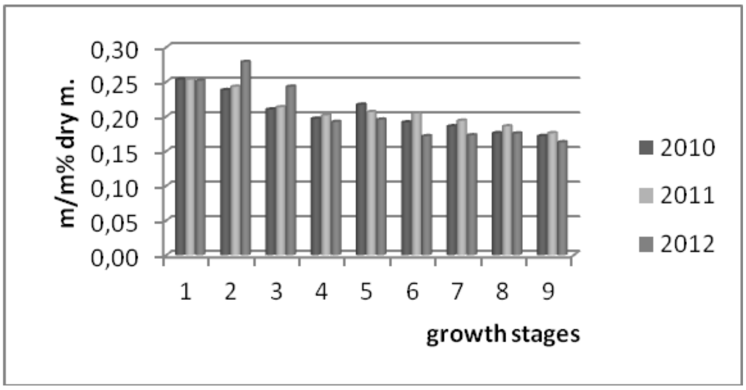

Figure 3. Changes in phosphorus level in grape leaves in different growth stages (1-9)

Phosphorus levels decreased continuously in the study period till harvest ($p<0.001$). Slight increase was shown after blooming only in 2012.

A slight continuous increase in Ca level was shown until stage 7-8 (from 1.88 to 2.76 mg/kg dry matter) reflecting weak mobilization of this element. Magnesium concentration increased from 0.31 in the beginning to the maximum of approximately 0.42; remaining almost constant in the observed vegetation period. Ca deficit was frequent in the rainy 2010 year (lower than 1.5 m/m% dry matter in 14.1% of the samples), whereas Mg deficiency was more common in the dry 2011 year (lower than 0.2% in 14.0% of the samples).

According to the ratio of nitrogen to potassium, a biphasic elevation-decrease wave was observed, mainly as a consequence of sharp changes in potassium level (*Figure 4*). High N/K ratio (threshold limit 5m/m% dry matter) was shown only in about 3% of the samples.

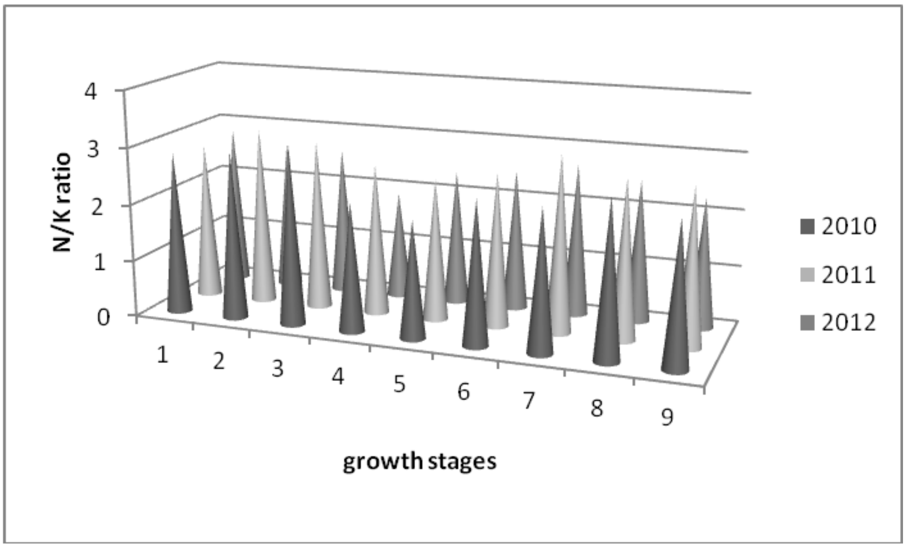

Figure 4. Changes in nitrogen/potassium ratio in different growth stages of grape in three consecutive years.

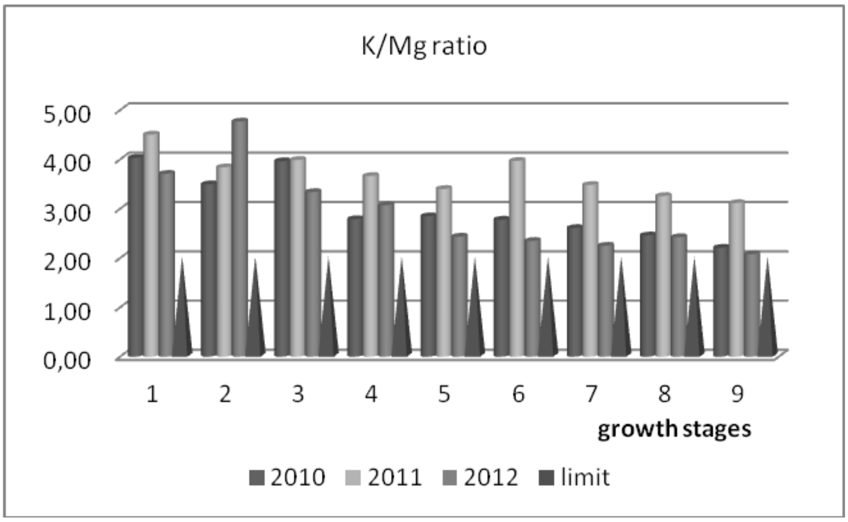

Figure 5. Potassium/magnesium ratio in different phenological phases of grape

Potassium to magnesium ratio decreased to the end of harvest (*Figure 5*). Threshold limit (2 m/m% dry matter) was reached in about 20-25% of the samples, due to decrease in potassium and moderate increase in magnesium.

CONCLUSIONS

In our three-year study period we examined changes in macronutrient levels in grape leaves, the frequency of the extremely high or low levels and ratios of main nutrients, that are taken into account in scientific literature. As we reported earlier, our laboratory makes leaf tests of about 10% of the nationally relevant plantations of the environment management grant cycle between 2010 and 2014 in Hungary. The majority of the tested plantations are vineyards. The most common types are Bianca, Cserszegi and Kékfrankos (PETŐ et al., 2011). In the Danube-Tisza region vine-growing is recommended primarily in mold sand soils (CSERNI-FÜLEKY, 2008). Weather and precipitation can also significantly affect nutrient management and water balance in plants. Only a small part of the vineyards is irrigated.

Grapes take up nutrients necessary for development at a different rate in the growing season. Nutrient content of the leaves therefore largely depends on the time of sampling (SCHREINER, 2006; SZŐKE, 1995). Taking into account varying nutrient uptake dynamics and movement, our results confirm that only test results carried out during the same period are comparable. The level of the main nutrients decreased in grape leaves from blooming towards harvest in our study. Nitrogen content was satisfactory in the vast majority of our samples in the whole examined vegetation period. Two maxima of nitrogen content were observed, immediately after blooming and in the last third of maturity. Maximum concentration of potassium appeared about two-four weeks later. Experienced changes in their concentrations may be associated with their mobility. Average potassium levels were in the lower concentration range. Potassium uptake was the lowest in the dry 2011 year. Phosphorus content seemed to be the least mobile element with a constantly falling leaf concentration. Phosphorus level decreased continuously, and stayed in the lower concentration range during the whole vegetation period. Low phosphorus levels in leaves occurred in about 25% of samples, mostly in 2012, and typically in the second half of the vegetation period. In the tested grape plantations it is recommended to increase the amount of potassium and phosphorus fertilization.

The ratio of some nutrients may be more informative than the simple concentration of them. Most commonly accepted is the N/K ratio. The appearance of high N/K ratio was not typical in the tested vineyards. However, the ratio of potassium to magnesium decreased to the end of harvest (*Figure 5*) and seemed to be low in about 20-25% of the samples, due to aforementioned low level and decrease in potassium and moderate increase in Mg concentration.

Our results emphasize the importance of leaf analysis in addition to the soil test results. Leaf blade analysis recording the actual nutrient uptake and mobilization is important in considering the nutrient supply. The effects of changes in weather conditions need further investigations.

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