Review on Agriculture and Rural Development 2013. vol. 2. (1) ISSN 2063-4803

THE IMPACT OF ORGANIC AND MINERAL FERTILIZATION ON SUGAR CONTENT IN GRAPES

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ABSTRACT
The sugar content in grapes is a specific characteristic for each variety, and it is influenced within certain variation limits by soil and climate factors and by technological factors. Grape vine nutrition represents an important factor for ensuring good quality of wine products. We conducted research in order to comparatively assess the influence of two fertilization systems, organic and mineral, on the sugar content of grapes, varieties *Burgund* and *Silvana*. Organic fertilization was made with manure in doses of 30, 40 and 50 t/ha. For the mineral fertilization we used a complex fertilizer of the type NPK (S), zinc fertilizer [15/15/15(+3+Zn)], in doses NPK_{50}, NPK_{100} and NPK_{150} kg s.a./ha. Different plant nutrition ensured by the two fertilization systems led to different accumulation of sugars in each variety. *Burgund* variety accumulated sugars from 234.88 to 256.42 g/l, variation amplitude being between 14.33 – 21.54 g/l. For *Silvana* variety, the sugar content ranged between 158.07 and 196.68 g/l, with differences of 10.71 – 38.61 g/l.

Keywords: sugars, grape vine, *Burgund*, *Silvana*, organic and mineral fertilization

INTRODUCTION

Quality in viticultural production is the result of several soil, climate and technological factors that are differently valorised by grape varieties. Sugar content is an essential quality element for both table grapes and wine grapes.
Among bio-chemical components of grapes, sugars rank among the first ones with values between 120 and 250 g/l. Upon grape full maturity, the ratio between glucose and fructose, main components of sugars, is 0.82.
Together with soil and climate factors of major importance for grapevine (RANKINE *ET AL.* 1971; JONES & DAVIS 2000; PEUKE, 2009), technological elements can also substantially contribute to the increase of grape quality. Among technological factors, nutrition plays a very important role (BERTONI & MORARD 1982; CONRADIE & SAAYMAN, 1989).
Numerous researches have monitored and emphasised the impact of macro- and micro-nutrients on grape production and quality (NEILSEN *ET AL.* 1989, JACKSON & LOMBARD 1993, SPAYD *ET AL.* 1994, WADE *ET AL.* 2005, COLAPIETRA & ALEXANDER 2006, DOBREI *ET AL.*, 2009).
CONRADIE & SAAYMAN (1989) have presented the results of long-term researches on the impact of mineral NPK fertilisation on white wine composition and quality. Making petiole tests, they assessed the nutrition state and identified certain antagonistic relations between the nutrition ions in the plant (petiole) as well as the correlations between the nutrition elements and must quality. An important role is that of potassium ion in the diminution of nitrogen in the mist and of the acidity.
The effect of the combinations of macro- (N, Mg, and K) and micro-elements (Fe, Zn) in the guidance of nutrition in grapevine allowed the identification of some positive and negative correlations between grape production, grape quality, and grapevine nutrition state (AMIRI & FALLAHI, 2007).
The increased interest in biodynamic and organic productions in viticulture have determined the development of research to assess the importance of soil as a nutrition

environment, of organic fertilisers as a source of nutrients and the adaptation of grapevine cultivation technologies to the new concepts (REEVE *ET AL.*, 2005).

Taking into account the general context of research in the field of viticultural production quality through the guidance of technological factors among which nutrition is one of the most important factors, we have studied the impact of two types of fertilisation – organic and mineral – on grape production quality in the varieties *Burgund* and *Silvana*, from the point of view of sugar content.

MATERIAL AND METHOD

Research was carried out at the Didactic Station in Timişoara, on the fruit tree and grapevine plantation. Soil and climate conditions are favourable to grapevine culture. The soil is a chernozem with physical and chemical features that make it a medium-fertility soil: $pH_{H_2O} = 6.71$, H = 2.76%.

Climate conditions are characterised by mean annual precipitations of 630 mm and by mean temperatures of 11.3^{0}C. The mean annual duration of sunshine is 2,100-2,200 hours, the variation of the annual duration being described by the relation $y = 1.9769x + 2108.3$ (Source: Meteorological Station of Timişoara).

The biological material was represented by two varieties of grapevine – *Burgund* and *Silvana*. The experimental variants were based on two types of fertilisers – organic and mineral – at different rates: animal manure at three rates (M_{30}, M_{40}, and M_{50} t/ha); complex NPK fertilisers, and zinc fertilisers [15/15/15(+3+Zn)] at three rates NPK_{50}, NPK_{100}, and NPK_{150} kg a.s./ha. We have assessed sugar content in grapes upon harvesting, after fertilising with both organic and mineral fertilisers. Measuring sugar content was done with the refractometric method. Data were processed statistically with the variance analysis. To interpret results statistically, we calculated the standard error and we assessed the impact level of the factor fertilisers on sugar content in grapes and the significance degree of the differences.

RESULTS AND DISCUSSIONS

Results of research concerning grape quality from the point of view of sugar content after fertilising with organic and mineral fertilisers (nutrition factor) are presented in Table 1 and Table 2.

Table 1. Sugar content of grapes in the variety *Burgund* under the impact of organic and mineral fertilisation at the Didactic Station of Timişoara (mean values, 2010-2011)

Experimental variants		Sugar content (g/l)	Relative values (%)	Differences	Significance
Mt		234.88±8.14	100.00	-	
Manure	30 t/ha	249.21±2.14	106.10	14.33	*
	40 t/ha	253.06±2.76	107.74	18.18	**
	50 t/ha	254.03±4.19	108.15	19.15	**
NPK	50 kg a.s./ha	241.45±2.97	102.79	6.56	
	100 kg a.s./ha	251.28±4.15	106.98	16.40	**
	150 kg a.s./ha	256.42±6.10	109.17	21.54	**

DL 5% 13.684
DL1% 18.200
DL 0.1% 23.673

Table 2. Sugar content of grapes in the variety *Silvana* under the impact of organic and mineral fertilisation at the Didactic Station of Timişoara (mean values, 2010-2011)

Experimental variants		Sugar content (g/l)	Relative values (%)	Differences	Significance
Mt		158.07±5.34	100.00	-	-
Manure	30 t/ha	180.07±7.58	113.91	22.00	*
	40 t/ha	183.78±8.00	116.27	25.71	**
	50 t/ha	174.75±3.95	110.55	16.68	-
NPK	50 kg a.s./ha	168.78±4.35	106.78	10.71	-
	100 kg a.s./ha	196.68±5.53	124.42	38.61	***
	150 kg a.s./ha	188.83±3.04	119.46	30.76	***

DL5% 16.701
DL1% 22.213
DL 0.1% 28.894

The two types of fertilisers and the rates applied had different impacts on sugar accumulation in grapes. The biological material, i.e. the grape varieties we studied, also responded in different ways to fertilisation: the highest sugar content was in the grape variety *Burgund* (256.42 g/l) and the highest increases in sugar accumulation after nutrition correction through fertilisation were in the grape variety *Silvana* (38.61 g/l in the variant NPK_{100} kg a.s./ha).

The comparative analysis of data show differences of sugar content generated by both fertilisation types and grape varieties because of the different biological potential of valorising vegetation factors, i.e. fertilisers (nutrients).

Sugar content in the grape variety *Burgund* ranged between 234.88±8.14 g/l in the control variant and 256.42±6.10 g/l in the variant NPK_{150} kg/ha a.s. Natural soil fertility ensured a sugar content of 234.88±8.14 g/l, figure 1, figure 2.

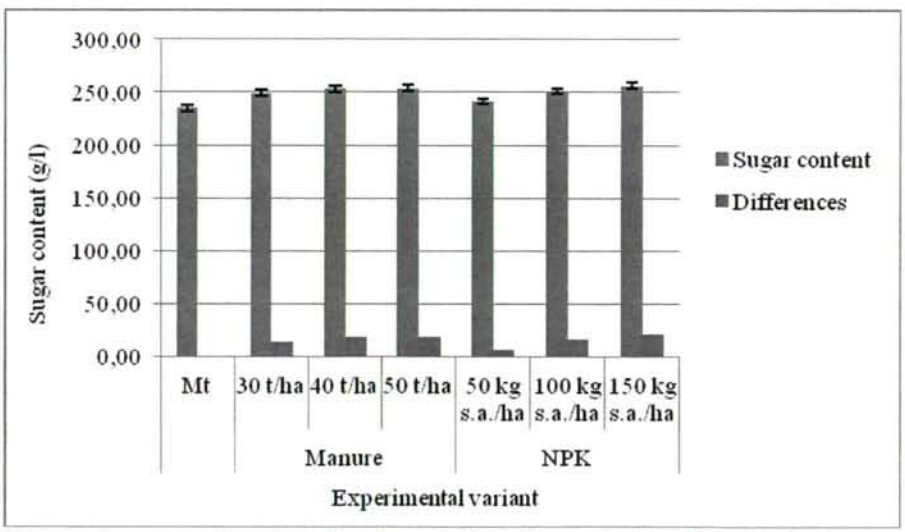

Figure 1. Sugar content of grapes in the variety *Burgund* under the impact of organic and mineral fertilisation at the Didactic Station of Timişoara (mean values, 2010-2011)

The grape variety *Silvana* valorised the fertilisers applied by accumulating a sugar content between 168.78±4.35 g/l in the variant NPK_{50} kg/ha a.s. and 196.68±5.53 g/l in the variant NPK_{100} kg/ha a.s. Natural soil fertility ensured a sugar content of 158.07±5.34 g/l.

Organic fertilisation determined a variation of sugar content between 174.75±3.95 g/l (M_{50}

t/ha) and 183.78±8.00 g/l (M_{40} t/ha) in the *Silvana* grape variety and a variation of sugar content between 249.21±2.14 g/l (M_{30} t/ha) and 254.03±4.19 (M_{50} t/ha) in the *Burgund* grape variety.

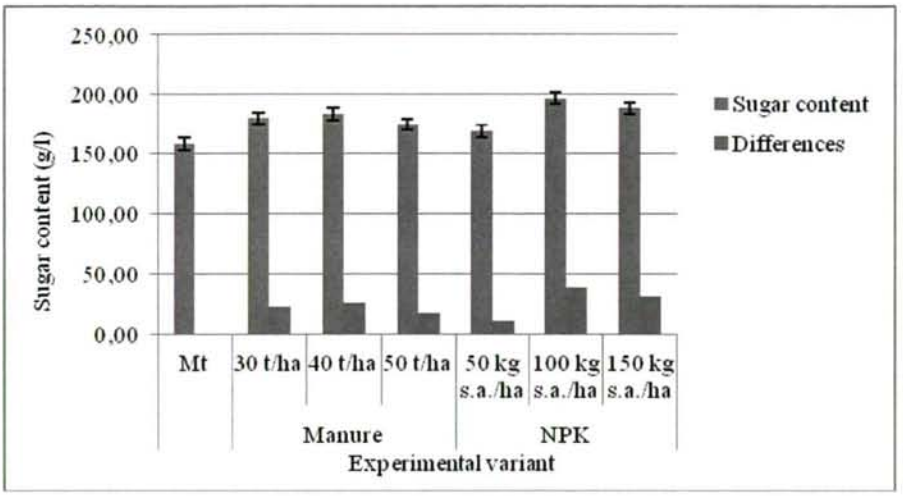

Figure 2. Sugar content of grapes in the variety *Silvana* under the impact of organic and mineral fertilisation at the Didactic Station of Timişoara (mean values, 2010-2011)

In the case of mineral fertilisation, sugar content ranged between 168.78±4.35 g/l (NPK_{50} kg a.s./ha) and 196.68±5.53 g/l (NPK_{100} kg/ha a.s.) in the *Silvana* grape variety and between 241.45±2.97 g/l (NPK_{50} kg a.s./ha) and 256.42±6.10 g/l (NPK_{150} kg a.s./ha) in the *Burgund* grape variety.

Organic fertilisation ensured an increase in sugar content between 14.33 and 19.15 g/l in the *Burgund* grape variety and between 16.68 and 25.71 g/l in the *Silvana* grape variety (figure 3).

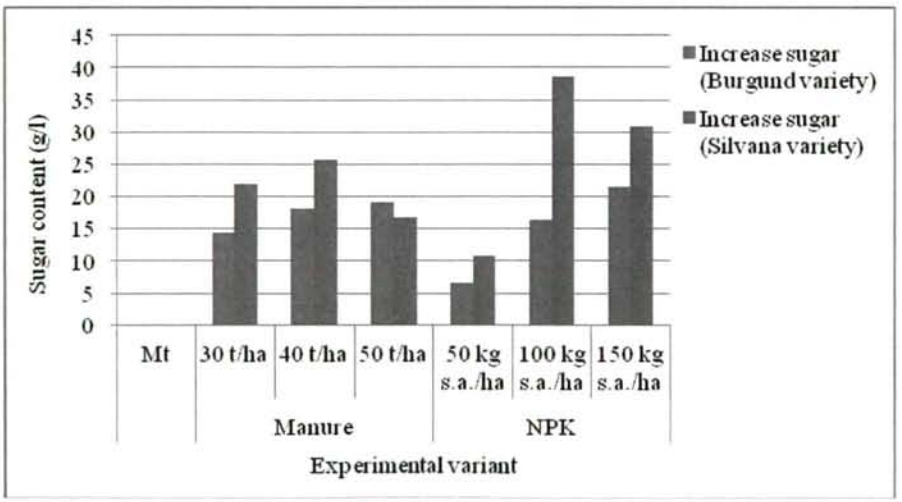

Figure 3. Sugar content increase in the *Burgund* and *Silvana* grape varieties under the impact of organic and mineral fertilisation at the Didactic Station of Timişoara (mean values, 2010-2011)

Mineral fertilisation determined increases of sugar content between 6.56 and 21.54 g/l in the *Burgund* grape variety and between 10.71 and 38.61 g/l in the *Silvana* grape variety.

CONCLUSIONS

Sugar content in grapes is determined by fertiliser type – organic or mineral – and rate of active substance applied.

Fertilisers are valorised in a different way depending on the type of grape variety. According to our own research, the *Burgund* grape variety yielded a higher content of sugars for the same rates of fertilisers compared to the *Silvana* grape variety, though the latter one yielded more sugars per rate of nutrient.

Organic fertilisation with animal manure determined increases of the sugar content between 6.10 and 8.15% in the *Burgund* grape variety and between 10.55 and 16.27% in the *Silvana* grape variety.

Mineral fertilisation determined increases of the sugar accumulation rate between 2.79 and 9.17% in the *Burgund* grape variety and between 6.78 and 24.42% in the *Silvana* grape variety.

The *Silvana* grape variety better valorised both organic and mineral fertilisation: the increase of the amount of accumulated sugar is higher compared to the *Burgund* grape variety but the rate of specific sugar content is lower.

REFERENCES

ANDREAS D. PEUKE, (2009): Nutrient composition of leaves and fruit juice of grapevine as affected by soil and nitrogen fertilization, Journal of Plant Nutrition and Soil Science, Volume 172, Issue 4, pages 557–564.

D. I. JACKSON AND P. B. LOMBARD, (1993): Environmental and Management Practices Affecting Grape Composition and Wine Quality - A Review, Am. J. Enol. Vitic vol. 44 no. 4, p. 409-430.

DOBREI A., GHITA ALINA, CRISTEA T., SFETCU ANDREEA, (2009): The influence of soil maintenance systems on vigor, quantity and production quality at some grape varieties for wine, Journal of Horticulture, Forestry and Biotechnology, vol 13, pg.197-200, Ed. Agroprint Timişoara;

G. BERTONI & P. MORARD, (1982): Blade or petiole analysis as a guide for grape nutrition, Soil Science and Plant Analysis, Volume 13, Issue 8, pages 593-605.

G. H. NEILSENI, D. S. STEVENSONI, J. J. FITZPATRICK, (1989): The Effect of Municipal Wastewater Irrigation and Rate of N Fertilization on Petiole Composition, Yield and Quality of Okanagan Riesling Grapes, Can. J. Plant Sci. 69:1285-1294.

GREGORY V. JONES, AND ROBERT E. DAVIS, (2000): Climate Influences on Grapevine Phenology, Grape Composition, and Wine Production and Quality for Bordeaux, France, Am. J. Enol. Vitic., Vol. 51, No. 3, p. 249 – 261.

JENNIFER R. REEVE, L. CARPENTER-BOGGS, JOHN P. REGANOLD, ALAN L. YORK, GLENN MCGOURTY, AND LEO P. MCCLOSKEY, (2005): Soil and Winegrape Quality in Biodynamically and Organically Managed VineyardsAm. J. Enol. Vitic. 56:4, p. 367 – 376.

JESSICA WADE, BRUNO HOLZAPFEL, KERRY DEGARIS, DAVID WILLIAMS, MARKUS KELLER, (2004): Nitrogen and Water Management Strategies for Wine-grape Quality, Proc. XXVI IHC – Viticulture - Living with Limitations, Eds. A.G. Reynolds and P. Bowen, Acta Hort. 640, ISHS, p. 61 – 67, Publication supported by Can. Int. Dev. Agency (CIDA).

M. COLAPIETRA, A. ALEXANDER, (2006): Effect of Foliar Fertilization on Yield and Quality of Table Grapes, Proc. Vth IS on Mineral Nutrition of Fruit Plants, Eds. J.B. Retamales and G.A. Lobos, Acta Hort. 721.

MOHAMMAD E. AMIRI, ESMAEIL FALLAHI, (2007): Influence of Mineral Nutrients on Growth, Yield, Berry Quality, and Petiole Mineral Nutrient Concentrations of Table Grape, Journal of Plant Nutrition, Volume 30, Issue 3, pages 463-470.

RANKINE B. C., (1971): Fornachon J.C.M., Boehm E.W., Cellier K.M., Influence of grape variety, climate and soil in grape composition and on the composition and quality of table vines, Vitis 10, p. 33 – 50.

S. E. SPAYD, R. L. WAMPLE, R. G. EVANS, R. G. STEVENS, B. J. SEYMOUR, C. W. NAGEL, (1994): Nitrogen Fertilization of White Riesling Grapes in Washington. Must and Wine Composition, Am. J. Enol. Vitic vol. 45 no. 1 34-42.

W. J. CONRADIE AND D. SAAYMAN, (1989): Effects of Long-Term Nitrogen, Phosphorus, and Potassium Fertilization on Chenin blanc Vines. II. Leaf Analyses and Grape Composition, Am. J. Enol. Vitic vol. 40 no. 2, p. 91-98.

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