INFLUENCE OF FOUR FOLIAR FERTILIZERS ON THE QUALITY AND QUANTITY OF THE PRODUCTION OF CABERNET SAUVIGNON GRAPES IN THE CONTEXT OF IRON CHLOROSIS

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Abstract

The quantity and quality of the grape crop in the conditions of iron deficiency may be significantly improved by the use of foliar fertilizers. Among the four types of foliar fertilizers, the best results in mitigating the effects of iron deficiency were attained by the fertilizers which, in addition to a complex mineral composition, also had a content of organic matter in the form of humic acids (V4) or protein hydrolysate (V5). The differences show that the organic elements have a stimulating influence on the plant metabolism and that the iron alone or even a complex foliar fertilizer with micro and macro-elements has a smaller impact on the crop (in terms of both quality and quantity) than the mineral-organic combinations. Moreover, a less favourable aspect can also be noticed, namely the fact that the fertilizers with an organic content contributed to a larger extent to the increase of the total nitrogen content in the grape, possibly influencing the wine clarification process.

Key words: iron chlorosis, grapevine, grapes, iron, foliar fertilizers

Iron chlorosis is a physiological phenomenon which has a negative impact on the agricultural cultures. In Romania, the most affected species are the grapevine and the peach tree, but less frequently it can also occur in other species such as bean, broccoli, cauliflower, fruit shrubs etc. (Budoi, 2000). Iron chlorosis mainly occurs on calcareous soils, especially on reason of the following main causes: high humidity and poor aeration (Lyndsay, 1980 and Thorne, 1954), in the conditions of a calcareous soil, result in the increase of the concentration of bicarbonate ions, which are at a great extent responsible for the immobilization of iron (Mengel, 1984). Iron has a complex role in plant nutrition, its main functions being related to its presence in: hemoproteins (catalase, cytochrome oxidase, peroxidases, leghaemoglobin etc.) and proteins with S and Fe (ferredoxin), the reversible Fe2+ - Fe3+ redox system, the chlorophyll synthesis and photosynthesis (Marschner, 1993, Burzo, 1999, Bergman, 1992). The lack of iron disturbs the entire physiological activity of the plant and it is visible throughout the culture cycle. The iron chlorosis symptoms can be seen in the whole plant, as follows: the leaves remain small, with the veins still green but with the accentuated yellowing of the interveinal space, and in more severe cases the leaf margins become necrotic and finally the leaf falls. The yellowing (chlorosing) starts at the growing tips of the plant because of a very low mobility of the iron, the shoots are weak and thin, with short internodes and a zigzag appearance; the grapes remain small (Tomoioaga, 2006).

Several methods have been adopted for the prevention and control of iron chlorosis, but currently it is considered that after choosing a resilient rootstock, foliar fertilization is the second most efficient method to maintain the vines in a proper physiological condition. Initially the measures taken consisted of the administration of iron salts (ferrous sulfate, ferric sulfate, ferrous ammonium phosphates and sulfates etc.) in the soil and on the leaves, but their efficiency was rather poor. Then the foliar fertilizations started to prove their efficiency, especially where the iron was complexed with EDTA, DTPA and EDDHA (Rusu, 2004). This study approaches the influence of four foliar fertilizers: one containing Fe with DTPA complex, one complex with micro and macro elements also including iron, and two organic-mineral complex fertilizers, one with humic acids and one with protein hydrolysate of animal origin.

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MATERIAL AND METHOD

In order to perform the research on the influence of foliar fertilizers on iron chlorosis in the grapevine, the Murfatlar Vineyard was chosen due to its specific pedoclimatic conditions, mainly its soils with a high calcium carbonate content and consequently with a high chlorosing power.

From all the farms where signs of iron chlorosis were noticed, we chose Farm 8, Parcel VN 1151 (*photo 1*), currently cultivated with *V. vinifera*, Cabernet Sauvignon variety grafted on the Fercal rootstock (the rootstock most resilient to iron chlorosis). The plantation was created in 2007 with certified young plants.

Photo1: **Murfatlar, Farm 8 – VN 1151**

The experiment aimed at assessing the influence on the plants and grapes of four foliar fertilizers. It consisted of 5 experimental variants (4 fertilizers and 1 control) with 4 repetitions for each variant, 20 plants in all, in a randomized selection and marked in accordance with the variant and the repetition. The working method of this experiment involved four foliar fertilizations performed in the period June – August 2012. The spraying was made in the morning, in a calm wind-free atmosphere, at temperatures below 300C. A 2.5 litre manual pump was used for application. For each variant we used 700 ml of fertilizing solution, i.e. 175 ml solution / plant, solution per vine equivalent to a spraying volume of 600 litres per hectare.

In order to follow up the effect of the fertilizers on the grapevine we tested in the first place the grapes in terms of the crop mass, the quality (total sugar content and total acidity) and the variation of the macro and micro elements in the composition of the grapes.

- V1, non-treated control, the plants were sprayed only with water;
- V2, Foliarel Fe, the plants were sprayed with a fertilizing solution;
- V3, experimental fertilizer with NPK+Me made by ICPA Bucharest;
- V4, experimental fertilizer with NPK+Me and humic acids made by ICPA Bucharest;
- V5, experimental fertilizer with NPK+Me and protein hydrolysate made by ICPA Bucharest.

At the end of September 2012, the grapes were harvested, weighed and tested.

The grape crop was determined by weighing, by means of a calibrated technical balance. The content of dry substance was determined gravimetrically, by drying and weighing, the average mass of the grapes as well.

In order to determine the content of macro-elements of the grapes, a part of the grapes was dried in the drying oven at 700C until their mass remained constant, then ground in the grinding bowl and the resulting powder was submitted to the tests. The total nitrogen was determined by the Kjeldahl method with digestion in H2SO4 at 350°C, potassium sulphate and copper sulphate as catalyst. The phosphorus was determined by solubilization of the ash in hydrochloric solution and dosing as molybdenum blue by visible spectrophotometry. The potassium and the iron were determined from the same hydrochloric solution, by flame spectrophorometry and by atomic absorption respectively.

The total sugar content of the must was determined refractometrically after crushing of the grapes and separation of the must. The total acidity was also determined in the must, by the titrimetric method.

Table 1

Chemical composition of the fertilizers according to the experimental variants

Fertilizer composition	V1 (control)	V2	V3	V4	V5
	grams / litre				
Organic substances	0.00	0.00	0.00	10.00	10.00
Nitrogen (Nt)	0.00	0.00	84.81	43.19	59.08
Phosphorus (P_2O_5)	0.00	0.00	25.80	16.50	22.60
Potassium (K_2O)	0.00	0.00	29.40	24.00	27.00
Copper (Cu)	0.00	0.00	0.09	0.07	0.07
Zinc (Zn)	0.00	0.00	0.89	0.46	0.45
Iron (Fe)	0.00	60.00	19.71	23.22	26.57
Manganese (Mn)	0.00	0.00	0.14	0.10	0.11
Magnesium (Mg)	0.00	0.00	4.61	0.86	2.44
Boron (B)	0.00	0.00	0.91	0.81	0.47
Sulphur (S)	0.00	0.00	20.07	18.33	18.35

RESULTS AND DISCUSSIONS

With reference to the influence of the fertilizers on the average crop of grapes (*fig. 1*) by foliar application of the liquid fertilizer Foliarel Fe (V2), a statistically significant increase of the grape crop can be noticed, by 31% as compared to the non-fertilized control. By the application of the foliar fertilizer which contains NPK and Me (V3), the grape crop increased significantly, by 35% s compared to the non-treated non-fertilized control, due to the NPK and Me contents of the fertilizer.

The liquid fertilizer with NPK and Me along with humic acids (V4) applied on the leaves resulted in a statistically significant increase of the crop by 49% as compared to the non-treated non-fertilized control, due to the humic acids and to the fertilizer containing NPK in its matrix.

By the foliar application of the liquid fertilizer NPK, Me and protein hydrolysate (V5), a statistically significant increase of the average grape crop is recorded, i.e. by 50% as compared to the non-treated non-fertilized control.

With reference to the influence of the fertilizers on the average mass of the grape (*fig. 2*), the application of the foliar liquid fertilizer Foliarel Fe (V2) resulted in a 2.8% increase (statistically insignificant) of the average mass of the grape as compared to the non-treated non-fertilized control. The application of the foliar fertilizer containing NPK and Me (V3) resulted in a statistically insignificant 1.9% increase of the average mass of the grape as compared to the non-treated non-fertilized control. The application on the leaves of the liquid fertilizer containing NPK and Me along with humic acids (V4) resulted in a statistically significant 12% increase of the grape crop as compared to the non-treated non-fertilized control, due to the humic acids and to the fertilizer which contains NPK in its matrix. The application on the leaves of the liquid fertilizer containing NPK, Me and protein hydrolysate (V5) resulted in a statistically significant 11% increase of the average mass of the grape as compared to the non-treated non-fertilized control.

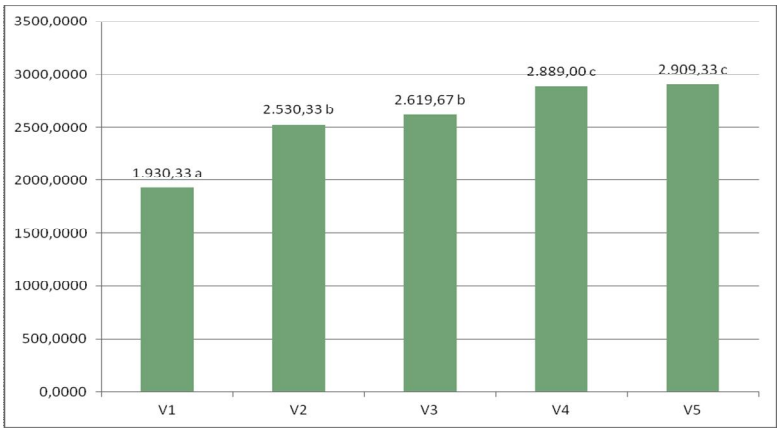

Figure 1. **Influence of the fertilizers on the average grape crop, in grams / vine**

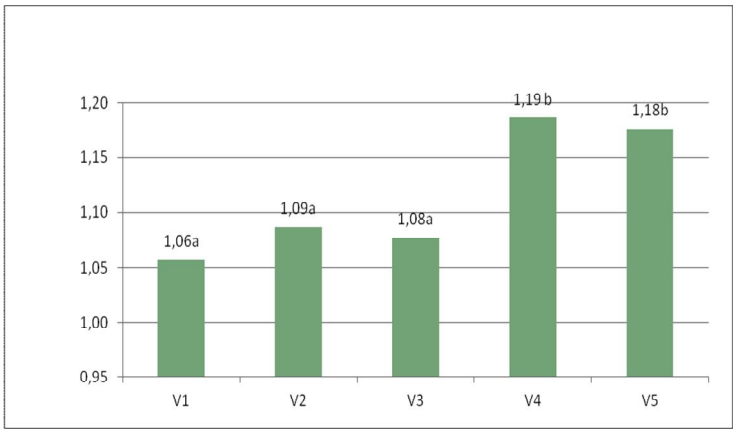

Figure 2. **Influence of the fertilizers on the average mass of the grape, in grams / grape**

With reference to the influence of the fertilizers on the total nitrogen content in the grapes (*fig.3*), the application on the leaves of the liquid fertilizer Foliarel Fe (V2) resulted in a statistically significant 12% increase of the total nitrogen as compared to the non-treated non-fertilized control. The application of the foliar fertilizer containing NPK and Me (V3) resulted in a significant 17% increase as compared to the non-treated non-fertilized control, to to the NPK and Me contents of the fertilizer. The application on the leaves of the liquid fertilizer with NPK and Me along with humic acids (V4) resulted in a statistically significant 20% increase of the total nitrogen content as compared to the non-treated non-fertilized control, due to the humic acids and to the fertilizer containing NPK in its matrix. The foliar application of the liquid fertilizer containing NPK, Me and protein hydrolysate (V5) resulted in a statistically significant 13% increase as compared to the non-treated non-fertilized control.

With reference to the influence of the fertilizers on the total phosphorus content in the grapes (*fig.4*), upon the foliar application of the liquid fertilizer Foliarel Fe (V2) no statistically significant change can be noticed as compared to the non-treated non-fertilized control. The application of the foliar fertilizer containing NPK and Me (V3) resulted in a significant 36% increase as compared to the non-treated non-fertilized control due to the NPK and Me content of the fertilizer. The foliar application of the liquid fertilizer containing NPK and Me along with humic acids (V4) resulted in a statistically significant 19% increase of the total phosphorus content as compared to the non-treated non-fertilized control. The foliar application of the liquid fertilizer containing NPK, Me and protein hydrolysate (V5) resulted in a statistically significant 21% increase as compared to the non-treated non-fertilized control.

With reference to the influence of the fertilizers on the total potassium content in the grapes (*fig. 5*), the fertilizers did not bring about statistically significant changes, except for the fertilizer containing NPK and Me (V3), which caused the increase of the potassium content by 43% as compared to the control.

With reference to the iron content in the grapes (*fig. 6*), the fertilizers had the following influence: the commercial fertilizer Foliarel Fe (V2) caused a statistically significant 26% increase as compared to the non-fertilized control; the mineral fertilizer with NPK and Me (V3) caused a statistically significant 23% increase as compared to the control; the fertilizer containing NPK, Me and humic acids (V4) caused a statistically significant 22% increase and finally, the fertilizer containing NPK, Me and protein hydrolysate caused a statistically significant 20% increase.

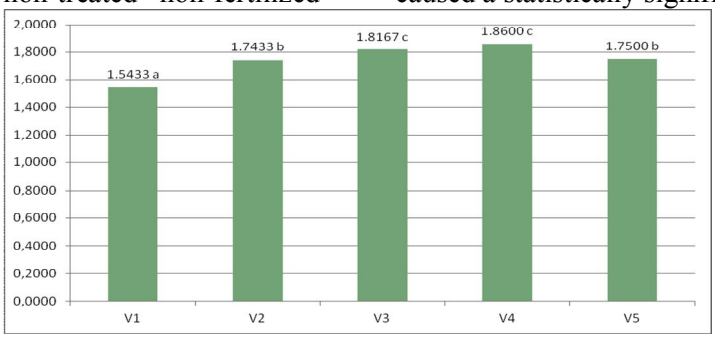

Figure 3. **Influence of the fertilizers on the total nitrogen content in the grapes – percentage in the fresh mass (Nt%)**

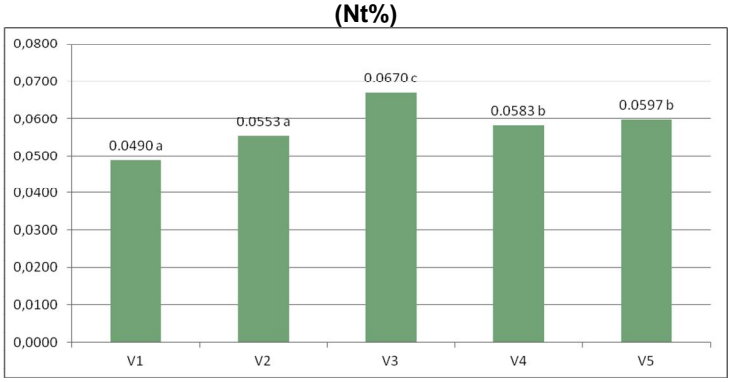

Figure 4. **Influence of the fertilizers on the phosphorus content in the grapes – percentage in the fresh mass (P2O5%)**

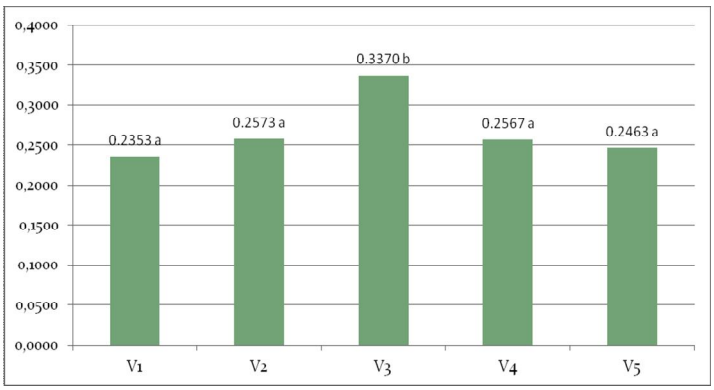

Figure 5. **Influence of the fertilizers on the potassium content in the grapes – percentage in the fresh mass (K2O%)**

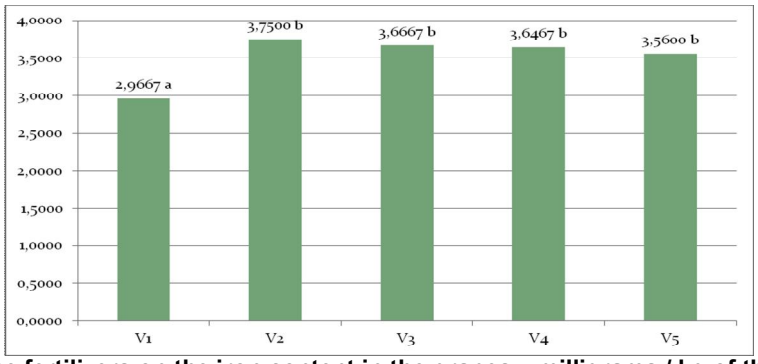

Figure 6. **Influence of the fertilizers on the iron content in the grapes – milligrams / kg of the fresh mass (Fe ppm)**

With reference to the influence of the fertilizers on two qualitative parameters of the must (the total sugar content – *fig. 7* - and the total acidity – *fig. 8*), the following can be noticed: the commercial fertilizer Foliarel Fe (V2) caused a statistically significant 2% increase of the total sugar content and a statistically significant 8% decrease of the acidity; the mineral fertilizer containing NPK and Me (V3) caused a statistically significant 2% increase of the total sugar content and 9% decrease of the acidity; the fertilizer containing NPK, Me and humic acids (V4) caused a statistically significant 9% increase of the total sugar content and 15% decrease of the acidity; the fertilizer containing NPK, Me and protein hydrolysate caused a statistically significant 7% increase of the total sugar content and 15% decrease of the acidity of the must.

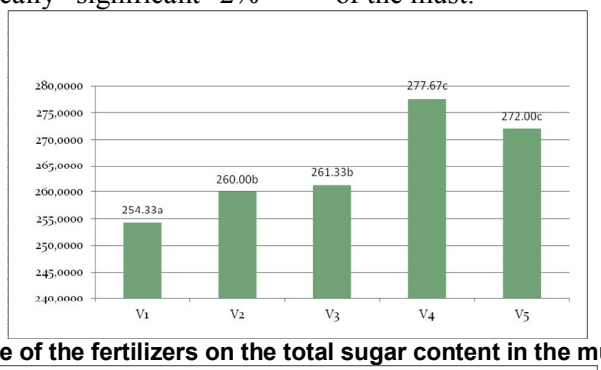

Figure 7. **Influence of the fertilizers on the total sugar content in the must– grams / liter**

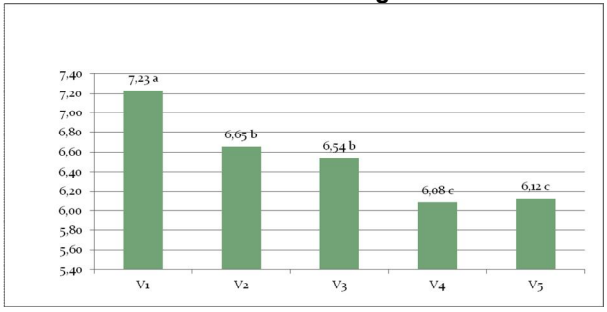

Figure 8**. Influence of the fertilizers on the total acidity of the must– grams / liter tratric acid**

CONCLUSIONS

The quantity and quality of the grape crop in the conditions of iron deficiency can be significantly improved by the use of foliar fertilizers. From the four types of foliar fertilizers, the best results in improving the effects of iron deficiency were attained by the fertilizers which had, in addition to a complex mineral composition, also a content of organic matter in the form of humic acids (V4) or a protein hydrolysate (V5). The differences show that the organic elements have a stimulating influence on the metabolism of the plant and that the iron alone, or even a complex foliar fertilizer with micro and macro elements, have a weaker impact on the crop (in terms of both quality and quantity) than the mineral-organic combinations. Further, a less favourable aspect has also been noticed, namely the fact that the fertilizers with an organic content contributed at a larger extent to the increase of the total nitrogen content in the grapes, possibly influencing the wine clarification process.

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