THE INFLUENCE OF ROOTSTOCK ON GRAPEVINE NUTRITIONAL DISORDERS INDUCED BY THE INCREASE OF SOIL CHLOROSANT POWER

INFLUENȚA PORTALTOIULUI ASUPRA DEREGLĂRILOR NUTRIȚIONALE LA VIȚA DE VIE INDUSE DE CREŞTEREA PUTERII CLOROZANTE A SOLULUI

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Abstract. *Under controlled conditions, using calcareous soils with $CaCO_3$ contents between 30 and 70% were studied the nutritional disorders induced by the increase of soil chlorosant power on three vinifera varieties grafted on seven rootstocks having a different resistance to iron chlorosis. The leaf diagnosis showed an increase of P, K, Mn and B contents and a decrease of N, Ca, Mg and Fe contents in the leaves of vinifera varieties in accordance with the increase of soil chlorosant power. This aspect determined a modification of global nutrition and especially of the nutritional equilibrium and of the nutritional ratio between macro and micronutrients related with rootstocks characteristics. Iron immobilization at the mesophyll level of leaves was correlated with the ratio P/Fe > 12, the ratio Fe/Mn near one value and with high ratio between K/Mg, K/Fe and K/Ca which expressed a potassium excess in the chlorotic leaves inducing an increase of leaves ash alkalinity and a high pH at the appoplast level causing an iron precipitation at this level.*
Key words: grapevine, nutritional disorders, iron chlorosis

Rezumat. *În condiții controlate, utilizând soluri calcaroase cu conținuturi de $CaCO_3$ total cuprinse între 30 şi 70% au fost studiate dereglările nutriționale induse de creşterea puterii clorozante a solului la 3 soiuri vinifera altoite pe 7 portaltoi cu rezistență diferită la cloroza ferocalcică. Analizele de diagnoză foliară au evidențiat o creştere a conținuturilor de P, K, Mn şi B şi o scădere a celor de N, Ca, Mg şi Fe în frunzele soiurilor vinifera pe măsura creşterii puterii clorozante a solului. Acest lucru a determinat o modificare a alimentației globale, dar mai ales a echilibrului nutritiv şi a rapoartelor nutriționale dintre macro şi microelemente, diferențiat în funcție de caracteristicile portaltoiului. Blocarea Fe la nivelul mezofilului frunzelor, care determină apariția simptomelor de cloroză a fost corelată cu raportul P/Fe > 12, raportul Fe/Mn apropiat de 1 şi rapoartele ridicate K/Mg, K/Fe şi K/Ca care evidențiază un exces de potasiu în frunzele clorozate, determinând o creştere a alcalinității cenuşii frunzelor şi implicit un pH ridicat la nivelul apoplastului, blocând prin precipitare Fe la acest nivel.*
Cuvinte cheie : vița de vie, dereglări nutriționale, cloroza ferică

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INTRODUCTION

The presence in excess of calcium carbonate in the calcareous soils determine a series of changes in soil chemistry which induce a disturbance of the main physiological and biochemical processes in plants, including mineral nutrition, finally leading to the appearance of iron chlorosis symptoms (Mengel and Geurtzen, 1986; Bavaresco et al., 1992; Fregoni and Bavaresco, 1997). In case of the vine these disorders are manifested differently according to the rootstock resistance to the chlorosant power of the soil (Pouget and Ottenwaelter, 1978). This study aims to identify these nutritional disorders and to establish their magnitude depending on the grafting partener in order to determine their impact on the manifestation of the iron chlorosis in vines.

MATERIAL AND METHODS

The research works have been carried out in pots under controlled environmental conditions using calcareous soils with total $CaCO_3$ content ranged between 30 to 70 %. It was mounted also a control treatment using a noncalcareous soil. Biological material was represented by grafted vines belonging to Afuz Ali, Feteasca regala and Cabernet Sauvignon varieties grafted on 7 rootstocks with different resistance to the chlorosant power of the soil, namely: K 5BB, Cr. 26, SO4-4, Precoce de Miniş, 41B, 59VI, Ru140 and Fercal. To determine the changes induced in the nutrition of vinifera/rootstock combinations have been carried out analysis concerning leaves content in macro and micronutrients and their ash alkalinity in June and August. It was also determined the chlorophyll content of the leaves and were noticed the appearance of iron chlorosis symptoms. Correlative links were established between soil carbonate content and the ash alkalinity of the leaves and their chlorophyll content, these data been interpreted in correlation with the appearance of iron chlorosis symptoms.

RESULTS AND DISCUSSION

The experimental results obtained showed that the presence in excess of calcium carbonate in the calcareous soils affected by an obvious way the macro and micronutrient nutrition of vinifera/rootstock combinations used in the experiment (table 1).

Table 1

The influence of the increase of soil chlorosant power on macro and micronutrient contents in vine leaves

$CaCO_3$ level	N %	P %	K %	Ca %	Mg %	Fe ppm	Mn ppm	B ppm
Control	2,96	0,23	1,02	3,04	0,25	240	113	36,5
30%	2,81	0,23	1,03	2,86	0,25	238	143	39,0
40%	2,79	0,25	1,09	2,85	0,23	228	147	40,7
50%	2,69	0,27	1,13	2,77	0,22	217	152	41,2
60%	2,67	0,30	1,16	2,74	0,22	201	150	40,8
70%	2,59	0,33	1,20	2,66	0,20	199	154	39,8

Considering the average values for the 21 vinifera/rootstock combinations it was noticed a decrease of N content in leaves (from 2.96% to 2.59%) and an increase of P content (from 0.23% to 0.33%) as well as of K content (from 1.02% to 1.20%), which highlights a change in nutrient balance in sense of increasing the share of P and K in vine nutrition in accordance with the increase of soil chlorosant power. The overall nutrition showed only a slight decrease because the reduction of N content in leaves was compensated by a corresponding increase of P and K contents (fig. 1).

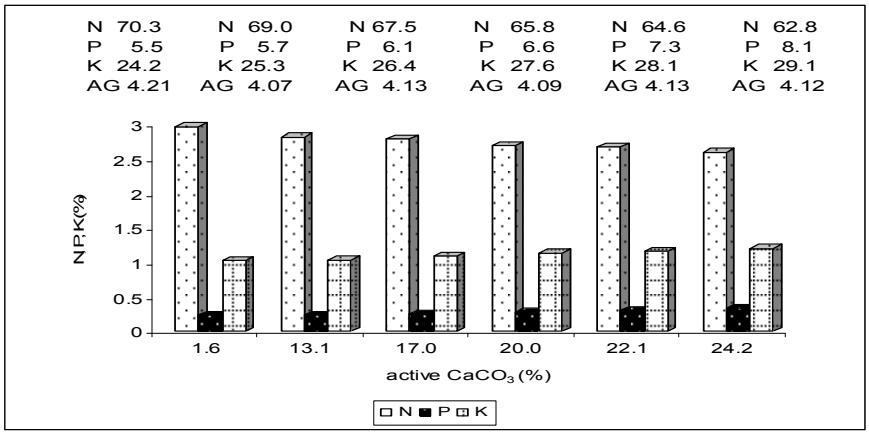

Fig. 1 – The evolution of NPK contents and of the nutritional equilibrium in vine leaves according to the increase of soil chlorosant power expressed by its content in active $CaCO_3$ (%)(mean values for the 21 vinifera/rootstock combinations)

Ca and Mg showed a slight tendency of decrease, whereas in case of micronutrients has been registered a slight decrease of Fe content and an increase of Mn and B contents in the vine leaves while the soil chlorosant power was increasing. The modifications induced in the vine nutrition determined also an obvious modification of the nutritional ratios between macro and micronutrients (table 2).

Table 2

The influence of the increase of soil chlorosant power on the main nutritional ratios in vine leaves (mean value for June and August)

$CaCO_3$ level	P/Fe	Ca/Fe	K/Fe	Mg/Fe	Fe/Mn	Ca/Mg	K/Mg	K/Ca
Control	9,6	126,6	42,5	10,4	2,1	12,2	4,1	0,33
30%	9,7	120,2	43,3	10,5	1,7	11,5	4,2	0,36
40%	11,0	125,0	47,8	10,1	1,5	12,4	4,7	0,38
50%	12,4	127,6	52,1	10,1	1,4	12,6	5,1	0,41
60%	14,9	136,3	57,7	10,9	1,3	12,4	5,3	0,42
70%	16,6	133,7	60,3	10,1	1,3	13,3	6,0	0,45

Thus, we can notice a clear increase of P/Fe and K/Fe ratios and a decrease of Fe/Mn ratio, which reaches almost the value of 1 in the chlorotic leaves. The

ratios Ca/Fe and Mg/Fe remained relatively constant with the increase of soil chlorosant power, because all the three nutrients showed a downward trend in the chlorotic leaves. It's important to mention also the increase of K/Mg and K/Ca ratios, this fact emphasizing a K surplus in the chlorotic leaves.

The modifications occurring in vine nutrition, mainly in case of the nutrition with alkaline nutrients, influenced the ash alkalinity of the leaves, inducing a constant increase of this one in correlation with the increase of soil chlorosant power (fig. 2).

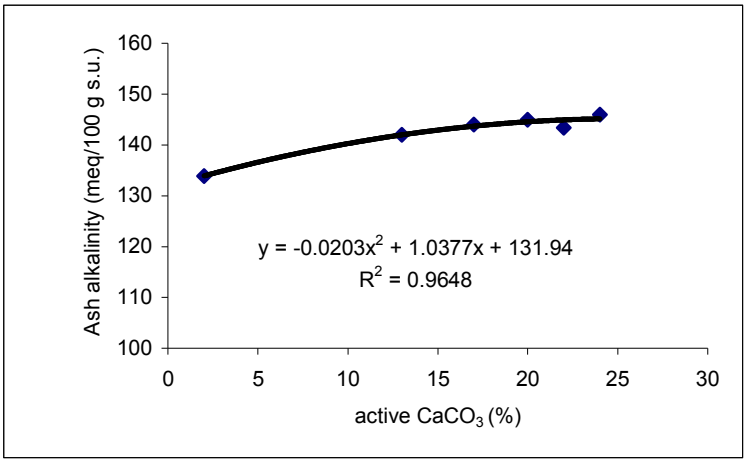

Fig. 2 - Relationship between the soil chlorosant power expressed by its content in active $CaCO_3$ and leaf ask alkalinity (mean values for the 21 vinifera/rootstock combinations)

We believe that the changes occurring in the nutritional ratios in vine leaves and the increase of the proportion of alkaline nutrients, especially K, induced a high pH at the level of the appoplast and the Fe precipitation at this space this one becoming thus inactive for the synthesis of the chlorophyll, even if quantitatively it was within relatively normal limits in leaves. In this respect the experimental data revealed a close correlation between the increasing of soil chlorosant power, the ash alkalinity and the chlorophyll content in leaves (figures 3 and 4).

The inactivation of Fe at the mesophyll level, phenomenon that causes the appearance of the iron chlorosis symptoms, was also correlated with the P/Fe ratio > 12 and Fe/Mn ratio close to one.

The nutrition of the three vinifera varieties planted on calcareous soils was influenced in an obvious manner by the rootstock used in the grafting combinations, their resistance to the soil chlorosant power being different according to their genetic origin.

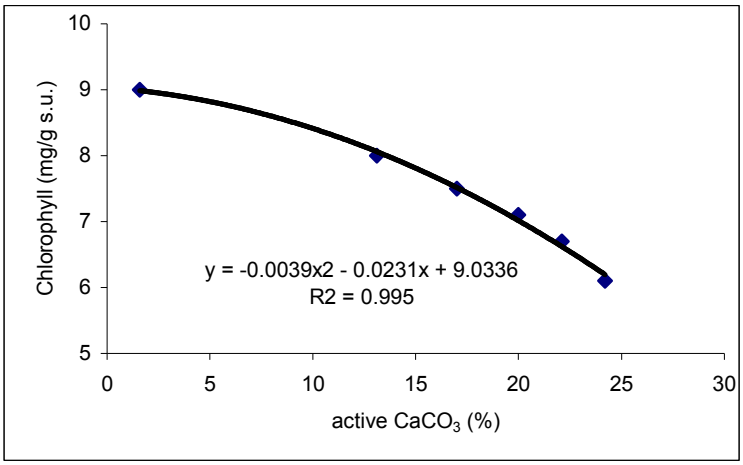

Fig.3 - Relationship between the soil chlorosant power expressed by its content in active $CaCO_3$ (%) and the chlorophyll content in vine leaves (mean values for the 21 vinifera/rootstock combinations)

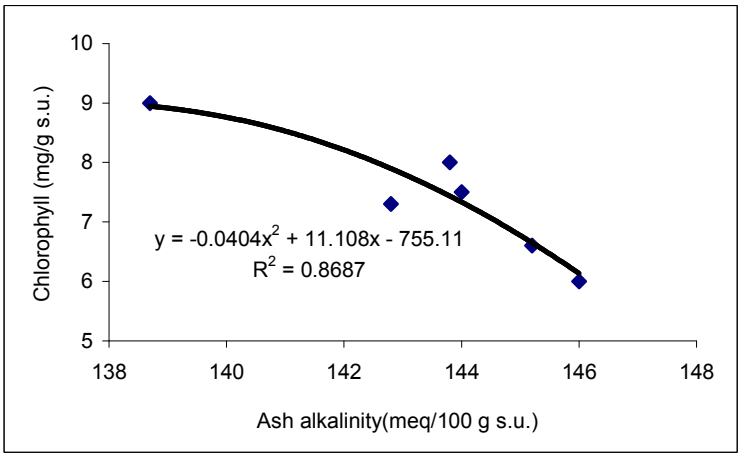

Fig.4 - Relationship between the leaf ash alkalinity of the vine leaves and the chlorophyll content (mean values for the 21 vinifera/rootstock combinations)

The analytical data emphasize the fact that under the conditions of a very chlorosant soil (70 % total $CaCO_3$) Fe concentration in the leaves of vinifera varieties and the value of the main nutritional ratios showing Fe nutrition (P/Fe, K/Fe and Fe/Mn) were highly influenced by the rootstock used in the grafting combination (table 3).

The biggest Fe concentration in the leaves and the balanced Fe/Mn, K/Fe and P/Fe ratios were registered in case of 140Ru 59Vl, Fercal and SO4-4 rootstocks, which have a highly resistance to the chlorosant power of the soil and a reduced one in case of Precoce de Minis and 41B rootstocks.

Table 3

Chemical composition of the leaves of vinifera varieties and some nutritional ratios according to the rootstock used in the grafting combination and to the level of total $CaCO_3$ from soil (mean values for the three vinifera varieties)

Rootstock	$CaCO_3$ level	N %	P %	K %	Fe ppm	Mn ppm	P/Fe	Fe/ Mn	K/Fe
K5BB	1*	3,24	0,25	1,03	211	117	11,8	1,80	48,8
	2**	2,66	0,36	1,20	196	165	18,4	1,19	61,2
C-26	1	2,94	0,23	1,02	215	80	10,7	2,68	47,4
	2	2,48	0,34	1,18	187	145	18,2	1,29	63,1
SO4-4	1	2,94	0,23	1,03	240	111	9,6	2,16	42,9
	2	2,65	0,33	1,20	219	137	15,0	1,60	54,8
Precoce Minis	1	2,98	0,22	1,01	240	143	9,2	1,68	42,1
	2	2,49	0,34	1,23	170	171	19,9	0,99	72,4
41 B	1	2,88	0,25	1,01	273	108	9,2	2,53	37,0
	2	2,56	0,36	1,19	180	187	20,0	0,96	66,1
140 Ru. 59 VI	1	2,90	0,21	1,05	229	100	9,2	2,29	45,8
	2	2,68	0,30	1,24	231	139	13,0	1,66	53,7
Fercal	1	2,79	0,24	1,03	284	137	8,4	2,07	36,3
	2	2,64	0,32	1,17	224	128	14,2	1,75	52,2

* - control; ** - treatment with 70% total $CaCO_3$ in soil

CONCLUSIONS

1. The modifications induced in the chemistry of the calcareous soils by the excess of calcium carbonate influenced in an obvious manner the mineral nutrition of vinifera/rootstock combinations

2. The leaf diagnosis showed in the chlorotic leaves high values for P, K, Mn and Fe contents and low values for N, Ca, Mg and Fe contents. This caused a change in nutrient balance and in nutritional ratios between macro and micronutrients.

3. The inactivation of Fe at the mesophyll level was correlated with the ratio P/Fe>12, the ratio Fe/MN close to one and the high values of the ratios K/Mg, K/Fe and K/Ca which have induced a high pH at the appoplast level

4. The mineral nutrition of vinifera varieties was strongly influenced by the rootstock used in the grafting combination

REFERENCES

1. **Bavaresco L. et al., 1992** - *Investigation on some physiological parameters involved in chlorosis occurrence in grafted vine,* Journ. of Plant Nutr. 15, p. 1791-1807
2. **Fregoni M., Bavaresco L., 1997 -** *Aggiornamenti scientifici sulla clorosi ferrica da calcare nella vite.* Vignevini, 9, p. 61-70
3. **Mengel K., Geurtzen G.,1986 -** *Iron chlorosis on calcareous soils. Alkaline nutritional conditions as the cause for the chlorosis,* Journ. Plant Nutr., 9, p. 161-173
4. **Pouget R., Ottenwaelter M.,1978** - *Etude de l'adaptation de nouvelles varieté de porte-greffes á des sols trés chlorosant,* Conn. Vigne Vin, 3, p. 167-175