THE CONTRIBUTION OF A COMPLEX OF TRACE ELEMENTS TO REALIZATION OF POTENTIAL OF GRAPE RESISTANCE TO LOW NEGATIVE TEMPERATURES

IMPACTUL COMPLEXULUI DE MICROELEMENTE ÎN REALIZAREA POTENŢIALULUI DE REZISTENŢĂ A PLANTELOR DE VIŢĂ DE VIE LA TEMPERATURILE NEGATIVE JOASE

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Abstract. *The resistance of perennial plants to the unfavourable conditions of growth is closely connected to the plant mineral status. Moreover, the trace element content that plays a very important role in many metabolic processes of plants is the basic limitative factor. As a rule, the soil under vine is insufficiently ensured with mobile forms of Fe, Mn, Zn, Ni, B etc. The efficacy of foliar treatment of vine with a specific complex of trace elements Microcom-V was studied in the greenhouse and field conditions. Foliar treatment of vine during the period of vegetation changed some physiological indices: intensification of phosphorus components and carbohydrate metabolism in leaves and shoots, free amino acids content in tissues, shoot growth and maturation. The modifications revealed led to the intensification of plant growth and development, formation and a fuller manifestation of genetically based potential of frost and winter resistance.*

Key words: resistance, vine, trace elements, xylem exudate, free amino acids, carbohydrates, phosphorus compounds

Rezumat. *Rezistenţa plantelor perene la condiţiile nefavorabile de creştere este strâns legată cu status-ul mineral al plantelor. Totodată, factorul principal limitativ este conţinutul de microelemente, care joacă un rol foarte important în multiplele procese metabolice ale plantelor. Ca regulă, solul în plantaţiile de viţă de vie este insuficient asigurat cu forme mobile de Fe, Mn, Zn, Ni, B etc. Eficacitatea tratamentului extraradicular a viţei de vie cu un complex specific de microelemente Microcom-V a fost studiată în condiţii controlate şi de câmp. Tratarea foliară a plantelor în perioada de vegetaţie a avut influenţă benefică asupra unor indicatori fiziologici: modificarea procesului de metabolizare a carbohidraţilor, conţinutului de compuşi fosforici, aminoacizilor liberi în ţesuturile plantelor, creşterea şi maturizarea lăstarilor, formarea şi manifestarea mai deplină a potenţialului de rezistenţă la ger şi iernare.*

Cuvinte cheie: rezistenţă, viţa de vie, microelemente, seva, aminoacizi liberi, carbohidraţi, compuşi fosforici.

INTRODUCTION

Vine grape, one of the most important species for the Republic of Moldova, is frequently injured due to exposion to critical negative temperatures during the winter period, they being the main factor of viticulture destabilization. The

majority of the varieties cultivated in the country, possess an enhanced genetic potential of producing capacity and resistance to frost and winter conditions. An eloquent objective provided for both intensive and ecological technologies within the strategies of a durable agriculture development in view of production of stable and high quality yields is to ensure the most complete manifestation of this potential.

Plant resistance to unfavorable factors is known to be a complex property. The multiple studies (H.J. Bohnert et al., 1995) have demonstrated that plant responses to stress are accompanied by accumulation of N-containing compounds (proline, other amino acids, polyamine compounds) and hydroxyl compounds (soluble glucides, oligosaccharides, sorbitol, inositol etc.)

The problem is to provide evidence demonstrating the impact of nutrients in this process. The perennial plant resistance to unfavorable growing conditions is closely connected with the plant mineral status. Moreover, trace element content that plays a very important role in many metabolic processes of plants is the basic limitative factor (Burzo I., Toma S. Et al., 2000; Toma S. et al., 2003; Alloway, 2006). As a rule, the soil under vine is insufficiently supplied with mobile forms of Fe, Mn, Zn, Ni, B etc. Therefore, it is important to provide plants with a necessary microelement complex during critical growth and development periods. A specific microelement complex, tentatively named Microcom-V, has been developed for this purpose.

This study has been conducted to elucidate the impact of the Microcom-V microelement complex on the accumulation of protective compounds meant to realize the winter resistance potential of vine plants. The efficacy of vine foliar treatment with this fertilizer has been studied in the greenhouse and field conditions.

MATERIAL AND METHOD

The studies have been performed on vine grape (industrial varieties Codrinschi and Aligote) from 2007 to 2009.The foliar treatment of plants with the Microcom-V microelement complex was carried out in three terms (1 – before flowering, 2 and 3 – at the stage of intensive shoot growth with an interval of 12-14 days). Water treated plants were used as control. Leaves were sampled for analyses in 3 and 6 days after foliar treatment, xylem exudate - at the budbreak stage.

The following analytical methods have been used: free amino acids using a AAA-300 analyzer, the phosphorus compound content after Bertran; microelement content using an atomic absorption spectrophotometer after dry calcination at 480^{o}C. Shoot growth and maturation was evaluated after the method of Lazarevskii M.A. (1963) and Alexandrescu I. et al. (1998).

The assessment of the vine resistance to winter conditions was conducted in the field conditions using the method developed by Cernomoreţ M. V. specifically for the vine crop (1985, 2000). The findings have been statistically manipulated using B.A. Dospekhov's method (1979).

RESULTS AND DISCUSSIONS

It is a common knowledge, that accumulation of glucides and other compounds having a stress protective action is one of the mechanisms of plant resistance to the action of negative temperatures, as well as other stress factors (E. Mazzucotelli et al., 2006; V.V.Kuznetsov, G.A.Dmitrieva, 2006). A dynamic evaluation of the glucide content in vine leaves after microelement treatment has demonstrated that the total glucides increase in the course of vegetation (Table 1).

The most favorable effect has been obtained after the treatment with the Microcom-V microelement complex. The more essential thing is an increase of the monosaccharide content. A concomitant insignificant increase of starch indirectly denotes an intensification of synthetic processes.

Treatment of plants with microelement solutions maintains the total level of free amino acids (FAA) during vegetation at a significantly higher level. The quantitative and qualitative changes are more pronounced after the third treatment (Table 1). Utilization of microelements in combination with other elements (Microcom-V) is more beneficial. The analysis of the qualitative content of FAA shows that the content of proline, valine, tyrosine, and phenylalanine grows in the treatments with microelements. The content of glutamic acid+glutamine rises by 2-3 times after three days of treatment.

Significantly, the content of FAA, particularly indispensable acids, increases in vine grapes, the highest value registered in the treatments with Dissolvin and the microelement complex. This evidences about a higher quality of grapes. The total sugars in berries increased only in the treatment with the microelement complex in comparison with the control.

Table 1

The content of sugars and free aminoacids (FAA) in vine organs, mg/100mg d.w.

Treatments	leaves						berries	
	5.06.07		19.06.07		10.07.08		28.08.07	
	FAA	Total sugars	FAA	total sugars	FAA	Total sugars	FAA	total sugars
Control	0,244	0,67	0,022	0,80	0,05	2,40	0,020	18,77
$FeSO_4$	0,262	0,93	0,024	1,13	0,103	3,06	0,036	17,77
$FeSO_4$	0,266	0,67	0,024	0,87	0,133	2,73	0,041	18,23
Microcom- V	18,23	1,07	0,028	1,33	0,164	3,46	0,052	19,67

Glucides and FAA are principal substances in perennial plant xylem exudate, as well. However, the relevant literature does not reflect the role of foliar treatment in the spring ascendant flow of protective compounds in vine grape.

The evaluation of the quantitative and qualitative content of glucides in xylem exudate has been carried out at the budbreak stage. Xylem exudate was sampled following the foliar treatment of plant with Fe salts ($FeSO_4$ and Dissolvin), $NiSO_4$ and the Microcom-V microelement complex in the preceding year. After the foliar treatment of plants in the preceding year, the xylem exudate contains significantly more glucides in comparison with the witness (fig. 1).

The content of saccharose, the principal transport form, has grown in the treatments with Microcom and $NiSO_4$ in the first place. The total content of glucides is the highest in the treatment with Fe in the form of chelate (Dissolvin) and with the microelement complex (Microcom-V).

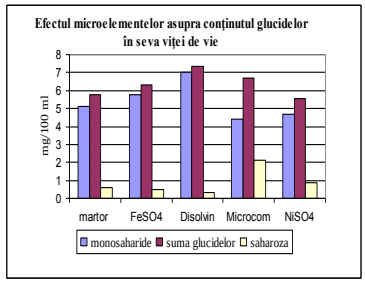

Fig.1. The content of glucide in vine xylem exudate, mg/100 ml, var.Codrinschi

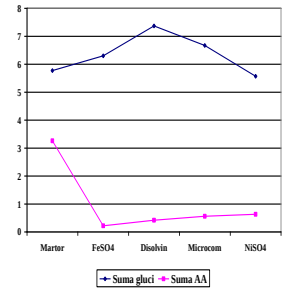

Fig. 2. The total content of glucides (mg/100 ml) and free amino acids (mkM/100) in vine xylem exudate.

Simultaneously, the content of free amino acids, that is the main form of the nitrogen reduced through vine xyleme, has been determined in xylem exudates (Burzo et al., 1999). About twenty free amino acids and amides have been found in xylem exudate. The findings received during two years allowed us to mention that the foliar treatment of plants during the vegetation contributes to essential modifications in xylem exudate composition: a sharp diminution of the total FAA content in the treatments with foliar treatment accompanied by an increase of the total glucide content (fig. 2).

Table 2

The quantitative content of amino acids in vine xylem exudate, % of the total content (2009)

Amino acids	Control	$FeSO_4$	Dissolvin	Microcom	$NiSO_4$
Asparaginic acid	5.70	13.1	10.20	5.00	7.50
Glutaminic acid	4.90	5.2	10.00	7.40	12.80
Proline	23.20	19.3	10.40	5.40	10.30
Tryptophane	7.80	5.2	2.60	5.10	5.10
Alanine	15.87	8.01	9.13	5.50	17.99
Glycine	10.00	5.2	5.30	6.40	7.00
Cysteic acid	2.20	9.9	14.10	6.90	8.00

The estimation of the quantitative FAA content in xylem exudate has demonstrated that the relative content of the so-called stress acids (Haldemann et al., 1988), proline and alanine, obviously reduces in comparison with the control. The diminution of the proline and tryptophane content, which results in peptide hydrolysis, may affirm the intensification of the synthetics processes at the

beginning of the vine vegetation in the plants treated the preceding year. The content of S-containing AA (cysteic acid et al.) increased.

Phosphorus compounds are very important for the development and manifestation of the frost and winter resistance degree. The studies carried out have revealed essential modifications in the content of some forms of these compounds in the vine organs after microelement treatment. A significant increase of the content of phosphorus lipids and nucleotides, acid soluble phosphorus and a significant reduction of etheric glucides has been established. The obvious modifications found in the content of the phosphorus compounds after the plants have been treated with the Microcom-V complex attest a beneficial effect of the microelements on enhancement of plant resistance to frost and winter conditions.

The optimization of the metabolic processes in the course of plant vegetation through application of microelements has influenced shoot growth and maturation. Table 3 summarizes the results of the estimation of the microelement effect on the length and maturation degree in the shoots in 2009.

The effect of the Fe-containing substances, especially Fe in combination with other microelements (Microcom-V) is much more pronounced than that of Ni.

Table 3

Growth and maturation of vine shoots depending on the foliar treatment, var. Codrinshi, October 31, 2009

Treatment	Total mean shoot length,M±m, cm	Mean mature shoot length, M±m, cm	Shoot maturation degree	
				± against control
Control	134,5±6,13	110,4±4,73	82,1	
$FeSO_4$ 0,3%	167,1±7,64	151,1±5,92	90,4	8,3
Dissolvin	152,3±5,34	131,7±3,41	86,5	4,4
Microcom -V	173,4±9,53	159,2±7,86	91,8	9,7
$NiSO_4$ 0,02%	141,8±4,20	119,5±3,12	84,3	2,2

The condition of vine buds after wintering in the plants treated with microelements during the preceding vegetation period has been assessed. The data obtained in the years 2008 and 2009 demonstrate that buds viability has increased significantly, the number of dead buds has decreased; the plants treated during the vegetation period of 2008 with Microcom or FeSO4 saved the highest number of viable buds. Eloquent results have been obtained regarding the condition of vine buds after the action of critical negative temperatures in the winter of 2009-2010, which proves a significant increase of bud viability (6%-8%) and reduction of the number of dead buds in the plants treated during the vegetation period with Microcom-V, Dissolvin, and FeSO4 in comparison with the witness.

CONCLUSIONS

1. The modifications in the content of amino acids, glucides, phosphorus compounds in vine tissues and xylem exudate under the influence of microelements confirm the impact of these elements, especially the Microcom-V microelement complex, on the regulation and stabilization of metabolic processes, enhancement of resistance to unfavorable temperatures.

2. The foliar treatment of vine grape during the vegetation period contributes to essential changes in spring in the composition of the ascendant flow: a sharp fall of the total content of FAA in the xylem exudate of the plants treated accompanied by an increase of the total glucide content.

3. The complex Microcom-V contributes to formation and a fuller manifestation of genetically based potential of frost and winter resistance of vine.

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