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**ВОЗДЕЙСТВИЕ МИКРОЭЛЕМЕНТОВ НА АНАТОМИЧЕСКОЕ СТРОЕНИЕ
И РЕГЕНЕРАЦИОННУЮ АКТИВНОСТЬ ОДНОЛЕТНИХ ПОБЕГОВ ВИНОГРАДА
EFFECTS OF TRACE ELEMENTS ON THE ANATOMY AND REGENERATIVE ACTIVITY
OF ANNUAL SHOOTS OF GRAPES**

**Никольский Максим Алексеевич, кандидат сельскохозяйственных наук, доцент
Панкин Михаил Иванович, доктор сельскохозяйственных наук, доцент**

Федеральное государственное бюджетное научное учреждение Анапская зональная опытная станция виноградарства и виноделия Северо-Кавказского зонального научно-исследовательского института садоводства и виноградарства, Анапа, Россия

E-mail: mcnik-anapa@mail.ru

Аннотация

Показаны результаты применения препаратов содержащих микроэлементы на промышленных маточниках винограда. Приведены корреляционные зависимости от содержания органических кислот и их влияния на анатомическое строение побегов. Установлено, что применение препаратов содержащих микроэлементы zinc и boron, оказывает влияние на количественные показатели анатомических структур, и регенерационную активность виноградных черенков.

Abstract

The results of the application of preparations containing trace elements in industrial grape queen cells are given. The correlation depending on the content of organic acids and their influence on the anatomical structure of the shoots are shown. It is found that the use of drugs containing the trace elements zinc and boron affects the quantitative indicators of the anatomic structures as well as the regeneration activity of the grape cuttings.

Ключевые слова: виноград, подвой, биоэффективные препараты, анатомическое строение, ризогенез, оптимизация питания.

Key words: grape, rootstock, bioeffectiveness, drugs, anatomical structure, root formation, optimization of power.

INTRODUCTION

Grapevines propagation is based on their regenerative capacity which depends on both the inherent properties (hereditary characters) of the plant and the set of environmental conditions [2].

One of the external factors that influence the regenerative capacity is nutrition. Given optimum nutritive conditions, grapevine shoots accumulate significant amount of carbohydrates and physiologically active substances, which guarantees quite mature plantings with high regenerative capacity [4].

The most active plant body nutrients capable of activating enzyme activity are trace elements, which can be explained by the fact that trace metals ions form chemical bonds with active groups of protein molecules thus forming organo metallic complexes that directly influence enzyme activity and excite metabolic activities [3].

Our studies were aimed at the goal of revealing the influence of the trace elements preparations over the anatomy changes and regenerative capacity of the one-year-old grapevine shoots.

Subjects and Methods of Research: The subjects of our research were rootstock mother plants of the grape variety of Kober 5BB (nursery of the OJSC Farming Firm *Yuzhnaya* of the Temriuk district).

We used the following as preparations: compound organo mineral fertilizer (*COMF*) – humic acids potassium salts: total nitrogen – 0.2%; total phosphorus – 1.5%; total potassium – 2%; and trace elements preparations containing the following: *Zinc* – 10-15%; *Boron* – 6-12%; *Iron* – 8-12%; *Copper* – 16-18%.

Tests were performed using instruments and analytical data of the Shared Knowledge Center of FGBNU SKZNIISiV.

RESULTS AND DISCUSSION

We used trace elements preparations as foliar applications, which resulted in the increased concentration of nutrients and organic acids in the grape leaves. The most significant increase was registered after the last treatment.

It is known that organic acids are intermediate compounds taking part in the oxidation of carbohydrates, fats, amino acids, and used in the synthesis of amino acids, alkaloids and other compounds, thus being the linker in the metabolism of carbohydrates, proteins and fats [1].

Data presented in Table 1 show that application of COMF resulted in the increased contents of malic, citric and chlorogenic acids, application of boron – of tartaric, succinic and caffeic acids, application of iron – of ascorbic acid.

The results of the comparative analysis (Pearson correlation coefficient) showed that the following elements had the greatest positive effect over the organic acids content: Na (0.72), Mg (0.77), and Ca (0.89) – over the chlorogenic acid content, Cu (0.95) – over the succinic acid content, Cu (0.95) – over the caffeic acid content, and Zn (0.81) – over the ascorbic acid content.

In addition to the increased concentration of nutrients and organic acids the application of trace elements preparations resulted in significant changes in the anatomy of the one-year-old shoots of the rootstocks of the grape variety of Kober 5BB.

Maturity of shoots and development of storage tissues are marked by the number of pith rays and radial rays as well as of the hard layers of bark. We found that the number of pith rays increased from 58 pcs. for the control sample to 72 pcs. for the boron variant (Table 2).

Total number of pith rays increased with the trace elements present due to the increased number of secondary radial rays. The number of pith rays in

shoots is directly associated with the number of the hard layers of bark; the greatest number of pith rays was registered at the boron (72 pcs.) and zinc (70 pcs.) variants.

These variants also had the greatest number of vessels: 1019 pcs. at the boron variant and 934 pcs. at the zinc variant.

We determined that the number of conducting vessels depended on the tartaric acid content, Pearson correlation coefficient being 0.64, the succinic acid content (0.73), and the caffeic acid content (0.68).

Preparations used caused changes in the ratio of wood to pith – the amount of wood increased. This was particularly marked at the variants with the application of boron and zinc resulting in the reduced pith: by 4.8% for the zinc variant and by 3.4% for the boron variant.

When determining the regenerative capacity we considered the following parameters of growth and development of cuttings: bud break, number and length of roots, length of shoots, and their growth dynamics.

The results of the conducted research showed that the maximum amount of buds broken was registered on the 21st day of observations, and that parameter had no changes later on. The longest shoots were registered for the boron variant – 20.1cm. Average number of roots was the largest at the boron variant – 5 pcs.

Analysis of the root formation dynamics showed that the process was the most intensive at the variants of boron and copper. Average length of the roots was maximal at the zinc variant – 4.6cm, and minimal – at the COMF variant (3.3 cm). The highest ratio of cuttings to roots was registered for the boron variant – 86.6%, next being the variants of copper and iron (80%), and the lowest ratio was that of the zinc variant – 46.6%. (Table 3).

Table 1. Organic acids content in leaves of the Kober 5BB rootstock variety after the last treatment

Treatment	Organic Acids, g/kg						
	Tartaric	Malic	Succinic	Citric	Ascorbic	Chlorogenic	Caffeic
Control sample	20.56	9.72	0.14	0.70	2.77	1.88	9.86
COMF	14.95	22.02	0.05	1.59	56.71	111.2	9.66
Zinc	19.04	14.71	0.13	0.87	5.61	4.68	1.28
Boron	20.09	15.06	0.60	0.98	30.94	24.53	67.88
Iron	13.72	19.54	0.04	1.48	72.05	56.54	4.79
Copper	19.59	19.76	0.18	1.38	32.28	0.53	3.76



Table 2. Effect of preparations used over the anatomy of the one-year-old shoots of the rootstocks of the grape variety of Kober 5BB

Treatment	Average number of vessels, pcs.	Number of pith rays, pcs.	Tissue, % of diameter			
			Phloem	Xylem	Phloem +Xylem	Pith, %
Control sample	850	58	18.3	54.7	73.1	26.9
COMF	801	67	16.9	55.2	72.1	27.9
Zinc	934	70	19.7	58.2	77.9	22.1
Boron	1019	72	20.6	55.9	76.5	23.5
Iron	660	66	16.8	57.3	74.1	25.9
Copper	736	68	19.4	54.8	74.2	25.8

Table 3. Effect of preparations used over the regenerative capacity of the one-year-old shoots of the rootstocks of the grape variety of Kober 5BB

Treatment	Bud break, %	Average length of shoots, cm	Average number of roots, pcs.	Average length of roots, cm	Number of samples with roots, %
Control sample	81.9	14.8	3.1	4.0	60.0
COMF	62.6	11.1	2.5	3.3	50.0
Zinc	73.3	11.3	3.9	4.6	46.6
Boron	67.2	20.1	5.0	4.3	86.6
Iron	68.5	13.1	4.5	3.8	80.0
Copper	69.2	14.1	4.4	4.1	80.0
HCP ₀₅	2.6	1.9	1.0	0.6	4.3

CONCLUSIONS

1. Application of preparations containing such trace elements as zinc and boron influences the amount of pith rays and radial rays, of conducting vessels, and of the hard layers of bark which are storage and strengthening tissues of the one-year-old shoots.

2. From the viewpoint of the total regenerative capacity the most effective preparation inducing growth-corrective effects was the boron variant which showed the greatest results for average length of the shoots and roots formation.

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