Increasing the output of grape seedlings using biostimulants of natural origin

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Abstract. In recent years, the viticulture industry, and the problems of producers of grape products have attracted more attention from the state and the public in terms of its contribution to GDP growth. Productivity and longevity of grape plantations directly depend on the quality of the planting material. Therefore, the relevance of research to obtain the highest yield of standard seedlings of valuable table grapes (Yubilei of Novocherkassk, Dubovsky pink, Bogatyanovsky, Vera) is undeniable. Two variants of biostimulators of growth have been studied: amino peptide agrochemical and a complex mean of chitosan and succinic acid in comparison with background fertigation. The highest yield of seedlings of the first grade level 71-76 % of the open ground nursery on light chestnut soils obtained by its cultivation with a three-time application of foliar fertilizing of amino peptide mean of biological origin Isabion at a dose of 2 l/ha with the addition seedlings output relative to the control 10-13% and the level of production profitability from 135 to 151 %.

Introduction

The total demand of Russian Federation winegrowers in planting material for the purpose of planting new and reconstructing old plantations is from 10 to 20 million pieces per year. The volume of self-rooted seedlings is from 5 to 15 % of the total demand. The region of the Lower Volga region is best suited for growing self-rooted planting material in terms of temperature and phytosanitary conditions of land. However, the factors that limit root ability and achievement of the necessary biometric indicators in open-ground nurseries are the lack of moisture and nutrition elements in the soil. The search for effective ways to increase root ability and output of standard seedlings of valuable grape varieties remain ns an urgent task for the region's grape nursery branch and management.

Based on the literature sources, the problem of increasing the reproduction rate and improving the quality of planting material for fruit and berry crops and grapes, and in general, the intensification of gardening is proposed to be solved in multiple ways. For example, experts recommend using the method of green cuttings for the same crop with the

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simultaneous use of other methods of reproduction. This increases the output of seedlings and contributes to the rational organization of labor in farms engaged in nursery [1, 2, 3].

To improve the quality of the resulting planting material of grapes, it is necessary to ensure the invigoration of cuttings from viral diseases and other pathogens, as well as the use of a set of measures to stimulate plants to achieve the specified biometric indicators while they are in the field [1, 4, 5, 6].

Among the measures to stimulate root formation and growth of shoots, the treatment of rooting vegetative parts of maternal plants with agrochemicals of various nature is very justifiably occupies one of the leading positions, since they are easy to include in the technological process, and the return in increasing of rooting and output of standard seedlings can reach 25-30 %. Data on the increase in rooting and output of standard planting material with the use of biostimulators of natural origin are scattered and need to be clarified for different crops. At the same time, natural remedies are not alien to plant organisms, and therefore are quickly involved in the metabolism, many of them are antistressants. In the natural environment, they decompose quickly without causing pollution. A positive aspect is the use of biostimulators, which are made from biological raw materials that are waste from food or any other production [6, 7].

The aim of the research was to find an agrochemical of biological nature that has the strongest effect on the output of table grapes seedlings of the first class.

The task was to evaluate the effect of biostimulators on the output of standard seedlings from open ground nursery on light chestnut soils of the Lower Volga and to analyze the economic efficiency of their use.

Objects and research methods

The objects of research were cuttings of valuable table grapes that were rooted in the open ground. The research plotwas located in the ESPC “Gornaya Polyana” in Volgograd, that is in 50 km South-East of the city center. The climate of the territory is sharply continental and arid. The average annual precipitation is 360 mm, with a hydrothermal coefficient of 0.6. The soilsare represented by light chestnut thin complexes with salt layers. The humus content in the arable layer was 1.83 %, pH 7.8. Soil availability of mineral nitrogen was low (1.1 mg / 100 g), mobile phosphorus - low (0.62 mg/100 g), and exchange potassium - average (19.0 mg/100 g). Studies were conducted in 2018 and 2019, the annual precipitation in 2018 was 412 mm, 2019-345 mm. The repeatability of the experiment was three times, the area of the experimental plot was 1.5 m^2.

For growing seedlings, furrow planting was used, according to the scheme [8] and the developed irrigation regime.In the autumn, plowing was performed applying phosphorus-potassium fertilizers at a dose of $P_{40}K_{40}$, in the spring, cover harrowing was performed. At the beginning ofMay, machinery aggregate cut furrows 0.25 m deep with a distance between them of 1.4 m, a drip tube was placed in the center of the furrow, over which a dark plastic film was lined. Two-row holes were made using a prong template, and three-eyed cuttings of valuable table varieties were planted in them with a length of 0.21...0.35 m. The distance between rows was 0.2 m, between cuttings in a row is 0.14 m. Planting rate 101388 PCs / ha.

The irrigation regime was maintained at the level of 90 % of the Lowest Waterholding Capacity (LWC) in the layer of 0.0-0.4 m from planting to the beginning of maturation of the vines, and later-70 % of the LWC in the layer of 0.0–0.6 m. Irrigation rates were 110 and 200 m^3/ha, the average irrigation rate for two years was 4000 m^3/ ha. The output of seedlings of the first class was determined, according to GOST RF 31783-2012 immediately after digging the nursery. The rooting rate of planted cuttings (amount of rooted out of planted cutting) was determined in September. Statistical data processing was performed according to the generally accepted method.

Two-factor field experience laid out on the following scheme:

Factor A-application of biostimulators of root formation and vegetative growth.

Option 1 - after soaking in water, the lower ends of the cuttings were kept in the agrochemical Ruther Bio for 3 hours (10 ml/1 l of water) + fertigation during the growing season, starting from the phase of the 3rd leaf $N_{10}P_5$ (three times) - control;

Option 2 - according to the scheme of option 1 + three foliar treatments with the agrochemical Isabion with spraying rate of 2 l/ha with an interval of 14 days;

Option 3 - according to the scheme of option 1 + three foliar treatments with the agrochemical "Chitosan Bioabsolute+succinic acid" (SA) 2 liters of concentrate per 1 ha with an interval of 14 days.

Factor B-table grape varieties: Jubilee Novocherkassk, Dubovsky pink, Bogatyanovsky, Vera, Kodryanka (control).

Root formation stimulator Ruther Bio is a derivative of seaweed with a high protein content. Using the method of enzyme hydrolysis, the proteins in the agrochemical were decomposed to amino acids. In addition, the Ruther contains prohormonal compounds-polysaccharides, glucosides, betaines, macro-and microelements are included. The Ruther nutrient complex activates callus formation and accelerates water absorption by the resulting roots [9].

As pointed by producers, the agrochemical Isabion represents the amino acid-peptide complex of plant origin, which penetrate the tissues of plants by means of diffusion. Its components are the basis for building cells of various specializations. Under the influence of this agrochemical, plants reduce energy input and achieve higher development levels at the final stage. It is important that this complex increases the resistance of plants to the harmful effects of salinity and drought. In addition, there are in the composition of Isabion elements and compounds: calcium 0,4...0,5; sodium 2,2 1,7...; chlorides from 2.3 to 2.9; sulfate of 1.1...1.4 %, nickel, copper, zinc [10].

The essence of the growth-regulating activity of the cationic polysaccharide chitosan complex is the gradual release of available forms of nitrogen. At the same time, as domestic and foreign authors pointed out, plants acquire immune properties, increased resistance to soil pathogens, and are able to resist drought and other abiotic stresses [9, 11, 12, 14].

Results and Discussion

Based on our previous studies on rooting of long cuttings of Amur vines [15], the increase in the biometric parameters of seedlings completely depended on the optimization of nutrition regimes, and rooting – on the regime of hydration, nutrition and stimulation of root formation of basal (nodal) ends of cuttings. Thus, the survival rate of cuttings (rooting) at the background level of mineral nutrition was at the level of 50.5 %, the use of the root formation stimulator Ruther Bio contributed to an increase in the number of rooted cuttings by 11.3 %. The combined use of the root formation stimulator, the amino acid-peptide complex Isabion and background fertigation increased the rootability of cuttings by 30 % in comparison with growing nursery only with the background application of fertilizers. Therefore, in further studies, root formation and vegetative growth stimulators were also used.

In our present experiment, we studied the percentage output of seedlings of the first class of valuable table varieties-Yubilei Novocherkassk, Dubovsky pink, Bogatyanovsky, Vera in comparison with the zoned variety Kodrianka that has been grown in the Low Volga region for more than 30 years. These varieties have been tested in the farms of the region of various forms of ownership and technological way, which showed that in the near future they will consist the basis for the production of fresh grapes in the region. The output of seedlings of the first class (from the number of rooted) of the studied samples of table grapes according to the variants of the experiment in open ground nursery is presented in table 1.

Table 1. Output of seedlings of the first-class table grapes by research options, %

Variety form	Years of research	Research option			Average among options	Increase / Decrease to the control
		Option 1(control)	Option 2	Option 3		
Kodrianka (control)	2018	62,2	72,4	67,1	67,2	
	2019	64,6	74,9	68,2	69,2	
	average	63,4	73,7	67,7	68,3	-
Yubileiof Novocherkassk	2018	61,6	73,6	64,4	66,5	
	2019	62,8	74,4	65,1	67,4	
	average	62,2	74,0	64,8	67,0	-1,3
Dubovsky pink	2018	59,8	70,2	63,2	64,4	
	2019	61,6	72,5	66,4	66,8	
	average	60,7	71,4	64,8	65,6	-2,7
Bogatyanovsky	2018	66,8	74,1	68,1	69,7	
	2019	69,0	75,2	69,0	71,1	
	average	67,9	74,7	68,6	70,4	+2,1
Vera	2018	67,1	74,7	69,3	70,4	
	2019	69,2	78,0	72,2	73,1	
	average	68,2	76,4	70,8	71,8	+3,5

For the Factor A: The Lowest Average Difference $(LAD)_{0,05}$=0,09
For the Factor B:$LAD_{0,05}$=0,08

The output of self-rooted seedlings of the first grade on the background of fertigation (option 1) in average for years of researches on avarietiyKodrianka (control) was at 63.4 %, the Yubileiof Novocherkassk– 62.2%, of Dubovskiypink 60.7 %, Bogatyanovski – 67,9 %, Vera is 68.2 %. On the varietiesYubilei of Novocherkassk and Dubovsky pink the output of standard seedlings was lower than in control option by an average of 1.3...2.7 percent, excluding seedlings ofthe variety Yubilei of Novocherkassk, when grown with foliar feeding with agrochemical Isabion.

In 2018, the output of standard saplings from open ground nursery in all the studied varieties was slightly lower than in 2019, in which we had more favorable weather conditions. The highest percentage was in the variety sampleVera with the use of foliar sprays of agrochemical Isabion (76.4 %). The difference among options without foliar feedings was 10 ... 13 %. The increase in the number of standard seedlings with the application of Chitosan Bioabsolute+SA was 4.9...of 7.4 %. The difference in the output of standard seedlings between the second and third options was significant and ranged from 5.6 to 9.9 % in favor of the use of the agricultural chemical Isabion.

Obtained data indicate that in years with a favorable temperature regime on light chestnut soils, rooting of grape cuttings occurs until the second decade of July. Foliar fertilization of the plantation has a direct impact on both rooting and increasing the number of seedlings of the first class.

Economic analysis helps to assess how profitable the use of biostimulants is. The cost of the agricultural chemical Isabion is significantly higher than the chitosan complex, but the increase in the number of standard seedlings in value terms was sufficient to cover the cost of its purchase.

Gross production of self-rooted seedlings from 1 ha ranged from 63 thousand pieces of first-class seedlings per 1 ha to 77.5 thousand pieces. The amount of expenses for cultivating a nursery of seedlings, regardless of the variety, according to the research options, varied from 916.5 to 924.5 thousand rubles per 1 ha, while the cost of one seedling was from 11.9 to 14.9 rubles.

In General, the cultivation of table grape varieties nursery is economically profitable. At the current wholesale price, the highest profit was obtained when the studied varieties has

been cultivated using foliar fertilizing Isabionfrom 1247 to almost 1400 thousand rubles per 1 ha, which corresponded to the level of production profitability from 135 to 151 %.

Cultivation of the grape nursery using foliar treatments Chitosan Bioabsolute-SA is also economically feasible, the cost per 1 ha increased slightly, while the level of profitability increased by 5 ... 24 % and for studied varieties of grapes ranged from 115 to 124 %.

Among the variety samples participated in the study, the most profitable variety was Vera.Its cultivation provided a level of production profitability of 151 %. Cultivation of high-value varieties Yubileyof Novocherkassk and Dubovsky pink had the same level of profitability of 115 %.

Data on the economic efficiency of growing seedlings of table grapes on light chestnut soils are given in table 2.

Conclusion

The highest output of first-class seedlings from open ground nursery on light chestnut soils was obtained when it was cultivated with three - time application of foliar sprayings the biological preparation Isabion at a dose of 2 l/ha. At this stage, an increase of 10-13% was provided. The use of chitosan Bioabsolute + SAmay be recommended as the cheapest biostimulator of vegetative growth with a high increase in the output of standard seedlings of 4.9-7.4 %.

Table 2. Economic efficiency of cultivation of table grape varietieson light chestnut soils of Volgograd on average over the years of research

Economic indicators	Variety sample	Research options		
		Opt. 1 (control)	Opt. 2	Opt. 3
The gross yield of seedlings of the first grade, PCs/ha	Kodrianka (con.) Yubileiof Nov. Dubovsky pink Bogatyanovsky Vera	64280 63063 61543 68842 69147	74723 75027 72391 75737 77460	68640 65699 65699 69552 71783
Salesprice, RUB / PC.	-	30,0	30,0	30,0
Salesrevenue, thous. RUB	Kodrianka (con.) Yubileiof Nov. Dubovsky pink Bogatyanovsky Vera	1928 1892 1846 2065 2074	2242 2251 2172 2272 2324	2059 1971 1971 2091 2153
Total costs, thous. RUB	-	916,5	924,5	918,5
Production Cost of 1 piece, RUB	Kodrianka (con.) Yubileiof Nov. Dubovsky pink Bogatyanovsky Vera	14,3 14,5 14,9 13,3 13,3	12,4 12,3 12,8 12,2 11,9	13,4 14,0 14,0 13,2 12,8
Profit, thous.RUB	Kodrianka (con.) Yubileiof Nov. Dubovsky pink Bogatyanovsky Vera	1011,5 975,5 929,5 1148,5 1157,5	1317,5 1326,5 1247,5 1347,5 1399,5	1140,5 1052,5 1052,5 1172,5 1234,5

Level of production profitability, %	Kodrianka (con.)	110	143	124
	Yubileiof Nov.	106	143	115
	Dubovsky pink	101	135	115
	Bogatyanovsky	125	146	128
	Vera	126	151	134

References

1. S.R. Roberto, R.C. Colombo, Horticulturae, **6(2)**, 23 (2020) https://doi.org/10.3390/horticulturae6020023
2. A.L. Uhls, N. Jolley, T.V. Johnston, J.D. Dubois, Food and Nutrition Sciences, **9(3)**, 268-276 (2018) https://doi.org/10.4236/fns.2018.93021
3. E.S. Gimenes, P. Kielse, K.L. Haygert, F.D. Fleig, D.E. Keathley, D.A. Bisognin, Journal of Horticulture and Forestry, **7(1)**, 8-15 (2015) http://doi.org/10.5897/JHF2014.0367
4. K.B. Fuller, J.M. Alston, D.A. Golino, Am. J. Enol. Vitic., **70(2)**, 139-146 (2019) https://doi.org/10.5344/ajev.2018.18067
5. J.Y. Cheon, M. Fenton, E. Gjerdseth, Q. Wang, S. Gao, H. Krovetz, L. Lu, L. Shim, N. Williams, T. Libbert, Am. J. Enol. Vitic., **71(3)**, 231-241 (2020) https://doi.org/10.5344/ajev.2020.19047.
6. T. Baby, B. Hocking, S.D. Tyerman, M. Gilliham, C. Collins, Am. J. Enol. Vitic., **65(2)**, 261-267 (2014) https://doi.org/10.5344/ajev.2014.13121
7. A. Ertani, P. Sambo, C. Nicoletto, S. Santagata, M. Schiavon, S. Nardi, Chem. Biol. Technol. Agric., **2**, 11 (2015) https://doi.org/10.1186/s40538-015-0039-z
8. A. Ovchinnikov, S. Grigorov, M. Ratanov, D. Keller, Nauch Zhurnal Ros NIIPM, **2(38)**, 88-104 (2020) http://doi.org/10.31774/2222-1816-2020-2-88-104
9. P. du Jardin, Sci. Hortic., **196**, 3-14 (2015) https://doi.org/10.1016/j.scienta.2015.09.021
10. *Syngenta annual review 2015* (Syngenta AG, Basel, Switzerland, 2016) https://www.syngenta.com/sites/syngenta/files/presentation-and-publication/updated/annual reports/2015/syngenta-annual-review-2015.pdf
11. L.A. Hadwiger, Plant Sci., **208**, 42-49 (2013) https://doi.org/10.1016/j.plantsci.2013.03.007
12. R. Sharif, M. Mujtaba, M.U. Rahman, A. Shalmani, H. Ahmad, T. Anwar, D. Tianchian, X. Wang, Molecules, **23(4)**, 871 (2018) https://doi.org/10.3390/molecules23040872
13. O. Goni, P. Quille, S. O'Connell, Pure Appl. Chem., **88(9)**, 881-889 (2016).https://doi.org/10.1515/pac-2016-0701
14. M. Aleksandrowicz-Trzcinska, A. Bogusiewicz, M. Szkop, S. Drozdowski, Forests, **6(9)**, 3165-3176 (2015).https://doi.org/10.3390/f6093165
15. N. Kurapina, O. Nikolskaya, Irrigated Agriculture, **1**, 46-49 (2019) https://www.doi.org/10.35809/2618-8279-2019-1-13