Efficiency of pre-planting treatment of grafted and own-rooted grape seedlings when grown in various soil and climatic conditions

Andi Magomadov[1], and *Alexander* Grigoriev[2*]

[1]The Chechen State University, Grozny, 364907, Russia
[2]All-Russian Research Ya.I. Potapenko Institute for Viticulture and Winemaking – Branch of the Federal Rostov Agricultural Research Centre, Novocherkassk, Rostov Region, Russia

Abstract. In the conditions of the Rostov region and the Chechen Republic in 2021-2023. Experiments were carried out to study the influence of pre-planting treatment of the basal (root) part of seedlings of the varieties Cabernet Sauvignon (grafted crop) and Levokumsky (root crop). The American phylloxera-resistant variety Kober 5BB was used as a rootstock for the Cabernet Sauvignon variety. As a result of the research, it was found that the yield of Cabernet Sauvignon seedlings from a grape school increased in all variants with the use of drugs and was on average higher by 16.9-25.2%, which is a significant indicator in grafted viticulture. The results of research experiments conducted on self-rooted seedlings of the Levokumsky variety show identical results. Treatment with Slavol increased the yield of rooted seedlings from the school in all concentrations. The concentration of 0.4% showed the greatest efficiency (54.4% versus 29.0% in the control), however, at concentrations of 0.5% and 0.6% a decrease in yield was observed, but the yield was higher than in the control, 52 .4% and 40.4% respectively.

1 Introduction

Growing grape seedlings is a long and labor-intensive process. Currently, there is a steady increase in vineyard area in the Russian Federation. The revival of this industry is due to several problems, one of which is the lack of quality planting material. The purchase of imported seedlings no longer solves the problem of meeting the needs of winegrowing farms, mainly due to sanctions and the unsuitability of imported varieties to the soil and climatic conditions of Russia [1]. Therefore, it is important to increase our own production of grape seedlings.

There are many ways to optimize the production of grape seedlings. This is the application of mineral fertilizers, the use of microfertilizers, the use of growth regulators and even physical influences (for example, furrowing). Each method has both advantages and disadvantages [2-4].

* Corresponding author: grigoriev_sanya_2033@mail.ru

For the Russian Federation, the use of plant growth regulators is an important tool for increasing agricultural productivity and ensuring food security. They help optimize the process of growing plants, making it more environmentally sustainable, which is an important step in the development of agriculture [5-8].

For many years, the most frequently used drug to stimulate the growth and root system of grapes is heteroauxin, the use of which does not always produce the desired result and ultimately does not justify its cost [9-10]. Taking this into account, the grape nursery industry continues to constantly search for alternative means that would be easily accessible and safe, and at the same time have a significant impact on the growth and quality of grape seedlings.

The classical technology for the production of grafted and own-rooted grape planting material at the moment does not provide the required number of high-quality annual seedlings at the final stage of cultivation, and therefore the study of new drugs in the production technology of grape planting material that help regulate plant growth is an urgent topic of research.

2 Materials and methods

The purpose of the research is to study the effectiveness of pre-planting treatment of the basal part of grafted and rooted grape seedlings with modern fertilizers when grown in different soil and climatic conditions. The objects of research are Cultimar, NanoSilicon and Slavol fertilizers, grafted seedlings of the Cabernet Sauvignon grape variety and self-rooted seedlings of the Levokumsky grape variety.

To achieve this goal, two experiments were carried out in different soil and climatic conditions from 2021-2023:

Experiment 1. Preplanting treatment of grafted seedlings of Cabernet Sauvignon grapes in the black soil conditions of the Rostov region (Novocherkassk): Option 1. Control - water 1 day; Option 2. Cultimar – 1 day; Option 3. Cultimar – 2 days; Option 4. NanoSilicon – 1 day; Option 5. NanoSilicon – 2 days. The experiment included 60 plants per variant.

Experience 2. Pre-planting treatment of root-bearing seedlings of the Levokumsky grape variety in the conditions of the Terek-Kuma sands of the Chechen Republic (Chervlenaya station): Option 1. Control - without treatment; Option 2. Slavol – 0.1%; Option 3. Slavol – 0.2%; Option 4. Slavol – 0.3%; Option 5. Slavol – 0.4%; Option 6. Slavol – 0.5%; Option 7. Slavol – 0.6%. The experiment included 300 plants per variant.

Cultimar fertilizer (0.2%) is a liquid biological fertilizer with anti-stress effect based on seaweed, contains: Free amino acids – 0.5%; Magnesium (MgO) – 5.0%; Sulfur (SO_3) – 12.0%; Boron (B) – 0.2%; Algae extract – 74.0%. Fertilizer *NanoSilicon* (0.02%) – microfertilizer based on 50% pure crystalline silicon, colloidal particles of which are stabilized with 6% iron, 1% copper, 0.5% zinc, 20% humic acids, 8% fulvic acids, 0.02% calcium , 0.01% boron. Fertilizer *Slavol* (0.2-0.7%) is a liquid microbiological fertilizer, contains: Azotobacter chroococcum - no less than $1x10^2/cm^3$, Bacillus megaterium - no less than $3x10^2/cm^3$.

The implementation of experiments and statistical processing were carried out according to the method of B.A. Dospehova (1985), observations were carried out according to the method of L.M. Maltabar (1982).

3 Results and Discussion

The survival rate of vaccinations at school using Cultimar increased compared to the control by 12.9%. A significant increase in survival rate is ensured by better development of the root system. The number of roots in the control was the smallest 7.1 pieces, with a diameter of 2.3 mm. In the experimental variants, the number of roots increased by 4.6-6.1 pcs. or 64.8-85.9%, and their diameter by 0.4-0.7 mm or 17.4-30.4%. The total length of the root system increased by 75.5-96.8%, which is significant. It is noteworthy that increasing the duration of preplanting treatment stimulates the development of the root system in length and number, but not in diameter. Thus, with a treatment duration of 2 days, the diameter of the root system was 0.3 mm smaller than with a treatment duration of 2 days.

Table 1. Survival rate and development of the root system during pre-planting treatment of grafted seedlings of the Cabernet Sauvignon variety (average 2021-2023).

Experience Option	Survival rate, %	Root system development		
		Number of roots, pcs.	Root diameter, mm	Total length, cm
Control – 1 d.	58.2	7.1	2.3	186.3
Cultimar – 1 d.	71.1	11.7	3.0	327.8
Cultimar – 2 d.	71.1	13.2	2.7	366.6
NanoSilicon – 1 d.	65.5	11.8	3.3	391.2
NanoSilicon – 1 d.	70.7	17.0	3.1	445.1
LSD_{05}	3.02	0.55	0.13	14.64
r	0.560	0.745	0.651	0.688

With the use of NanoSilicon, the survival rate of vaccinations in school increased compared to the control by 7.3-12.5%. The number of roots increased by 4.7-10.0 pcs. or 66.2-140.8%, and their diameter by 0.8-1.0 mm or 34.8-43.5%. The total length of the root system increased by 2.1-2.4 times, which is significant. When using NanoSilicon, the tendency to increase the number of roots and their total length with a decrease in the average root diameter with increasing treatment duration from 1 to 2 days also remains.

The leaf surface area of any plant is the main factor in its growth, development and determines potential and economic productivity. Measurements of the leaf surface area of the seedlings were carried out in early September before the growth was minted. High results on the leaf surface area of the seedling were obtained in variants using the Slavol preparation at a concentration of 0.4% - 1165.3 cm^2, at a concentration of 0.5% - 1280.2 cm^2 (Table 2).

Table 2. Development of one-year shoots of self-rooted grape seedlings of the Levokumsky variety during pre-planting treatment (average 2021-2022).

Experience Option	Growth length, cm	Maturation, %	Leaf area, cm^2	Total number of roots, pcs.
Control –without processsing	49.7	26.7	880.1	13.2
Slavol 0.1 %	57.4	38.5	1312.4	16.3
Slavol 0.2 %	57.4	37.5	920.5	15.8
Slavol 0.3 %	65.7	38.6	940.8	15.6
Slavol 0.4 %	79.2	39.7	1026.4	17.9
Slavol 0.5 %	75.8	38.6	1280.2	17.6
Slavol 0.6 %	72.1	38.8	1165.3	15.4
LSD_{05}	4.91	2.78	80.84	1.2
r	0.857	0.710	0.502	0.531

The best growth results were obtained in experimental variants treated with the Slavol growth biostimulator at concentrations of 0.4 and 0.5%: the shoot diameter at a height of 45 cm was 3.98 mm and 3.99 mm, respectively, versus 3.85 mm in the control. At the same time, the growth of the shoot was 72.1 cm and 75.83 cm, respectively, against 49.73 cm in the control, the ripening of the shoot was 38.8 and 38.5% and in the control 26.7%. In terms of the total number of roots per seedling, the best results were obtained in variants using Slavol at a concentration of 0.4 and 0.5%: 17.9 pcs. and 17.6 pcs., in the variant using 0.1% concentration the number of roots was 16.3 pcs.

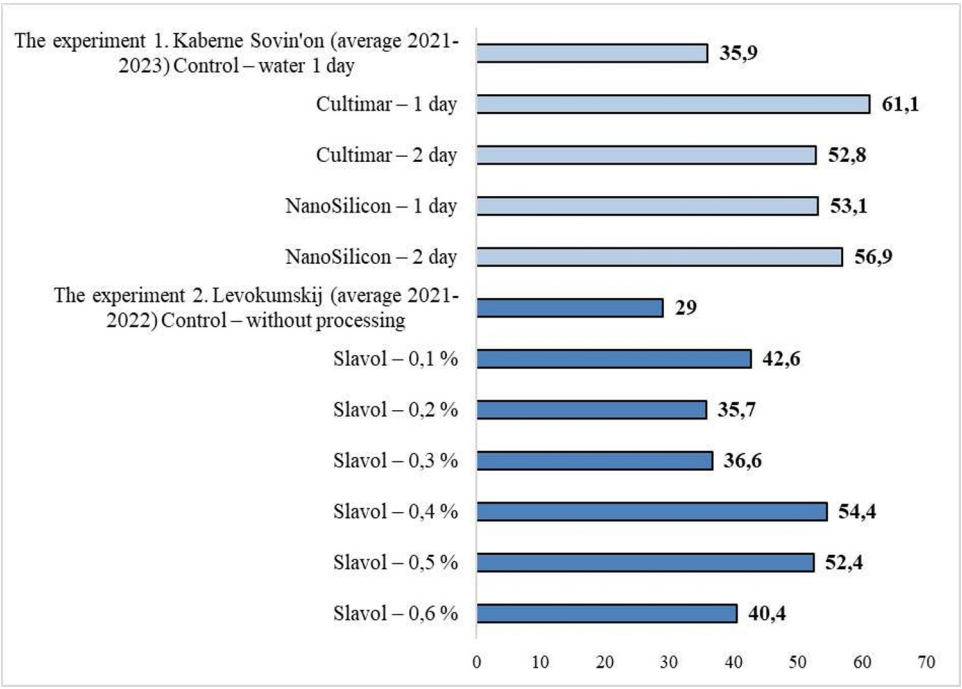

Fig. 1. Comparative analysis of the yield of grafted and rooted seedlings during pre-planting treatment with modern fertilizers, %.

Pre-planting treatment of the basal part of grafted seedlings of the Cabernet Sauvignon variety before planting ensured a final yield of 16.9-25.2% when using Cultimar more than the control option, and with the use of NanoSilicon the indicator increased by 17.2-21.0%, which is with HCP_{05}= 4.21 is significant.

In the control version of the second experiment, the yield of first-class seedlings was 8.9%, and with the use of the drug Slavol at a concentration of 0.1% - 17.3%. At the same time, the yield of first-class seedlings (the best indicators) was obtained in the variant using the drug Slavol at a concentration of 0.4% - 21.7% and at a concentration of 0.5% - 27.7% (Figure 1). The largest number of second-grade seedlings was obtained in the variant using the drug Slavol at a concentration of 0.4 and 0.5%, respectively 32.7% and 24.7%, and also using a concentration of 0.1% - 25.3%. The total yield of seedlings in the control was the lowest - 29.0%, and the highest in the following variants: 0.4%; 0.5% and 0.1%, where the yield was 54.4%, respectively; 52.4% and 42.6%, which is significantly more than the control and statistically significant (HCP_{05}= 3.12).

4 Conclusion

The study of pre-planting treatment of grafted and own-rooted grape seedlings when grown in various soil and climatic conditions showed high efficiency of the method. The highest yield of grafted seedlings of the Cabernet Sauvignon variety when grown in the black soil conditions of the Rostov region was 61.1% when using Cultimar with a treatment duration of 1 day. Slightly lower efficiency was obtained when using NanoSilicon - 56.9%, with a treatment duration of 2 days. For self-rooted seedlings of the Levokumsky variety grown on the Terek-Kumsky sands of the Chechen Republic, the greatest efficiency of reception was noted when using Slavol at a concentration of 0.4%, where the yield of seedlings was 54.4%. The data obtained can be used in specialized nursery farms, as well as in self-propagation of grapes to increase the efficiency of the process.

References

1. R.R. Ablaev, L.S. Abramova, A.R. Ablaev, International Agricultural Journal, **66**, **2** (2023) DOI: 10.55186/25876740_2023_7_2_20
2. A. Mamut, J. Huang, O. Andom, Science of The Total Environment, **895**, **165118** (2023) https://doi.org/10.1016/j.scitotenv.2023.165118
3. X. Li, J. Yang, H. Jia, Science Horticulturae, **308**, **111552** (2023) https://doi.org/10.1016/j.scienta.2022.111552
4. N. Zelenianska, I. Ishchenko, T. Kundilovska, O. Mandych, Scientific Horizons, **26**, **12**, 32-41 (2023)
5. A.V. Verzilin, Y. Fedulova, M. Pimkin, E3S Web of Conferences, **210**, **05003** (2020) DOI: 10.1051/e3sconf/202021005003
6. N.G. Pavlyuchenko, S.I. Melnikova, N.I. Zimina, O.I. Kolesnikova, Bulletin of KrasGAU, **10**, **187**, 16-21 (2022)
7. I.A. Avdeenko, A.A. Grigoriev, Vestnik KrasGAU, **9**, **198**, 3-9 (2023)
8. L.A. Titova, Magarach, Viticulture and winemaking, **20**, **3**, **105**, 53-55 (2018)
9. P.P. Radchevsky, Polythematic network electronic scientific journal of Kuban State Agrarian University, **105**, 293-315 (2015)
10. E. Ginda, Stiinta Agricola, **1**, 78-83 (2019)