Analysis of the development of grafted grape seedlings on a nursery garden of different graft-rootstock combinations

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Abstract. In 2019-2020, experiments were laid on the fields of the ARRIV&W – Branch of FRARC with the aim of experimentally determining the phenotypic signs of compatibility of scion-rootstock combinations with the participation of grape varieties of interspecific origin Denisovskiy and Prestige and rootstock varieties Kober 5 BB and Riparia Rupestris 101-14 introduced to the State Register of Breeding Achievements of the Russian Federation, approved for use. According to the results of the studies, it can be concluded that the selection of the optimal scion-rootstock for growing the necessary scion varieties has a direct effect on the yield of seedlings, which, with the same level of agricultural technology, will minimize production costs for inoculating seedlings and repairing grape plantations. The influence of the rootstock variety on the phenotypic characteristics of the scion variety has been established. The yield of seedlings is the most objective indicator of the compatibility of the scion-rootstock combination. According to the research results 2019-2020, it was found that the yield of first-class seedlings of the Denisovskiy and Prestige varieties significantly depends on the used rootstock variety. The Riparia Rupestris 101-14 rootstock has the highest yield of seedlings of the Denisovskiy variety, 45.4%, which is 21.6% more than on the Kober 5 BB rootstock variety. On the Denisovskiy variety, the seedling yield was 48.0%, which is 39.9% more than on the Kober 5 BB rootstock variety.

1. Introduction

Currently, there is a steady tendency to expand the area of vine plantations in the Russian Federation. The revival of the industry is due to a number of problems, one of which is the lack of quality grape planting material. The purchase of imported seedlings is not a universal way of satisfying vineyards in seedlings, due to the inability of imported clone varieties to the soil and climatic conditions of the grape-growing regions in the Russian Federation. That is why it is necessary to increase the yield of grape seedlings of local table and technical varieties.

A number of experts believe that at least 80% of the total number of plantations is allocated to the grafted vine plantations. Directly in European countries, this trend is observed mainly due to the presence of phylloxera in the soil. Using high-quality planting material, you can get up to 40% of poor-quality grafted seedlings at the exit from the stratification chamber. The reason for this phenomenon is the poor compatibility of the scion-rootstock components (anatomical structure and biological rhythm of development of different components), as a result of which the rootstock discards the scion.
Thus, the analysis of the literature on the selection of scion-rootstock combinations to increase the production of high quality seedlings indicates the need for in-depth scientifically grounded research work for each variety planned for industrial cultivation.

2. Materials and methods

The aim of the research is to experimentally determine the phenotypic signs of compatibility of scion-rootstock combinations with the participation of scion grape varieties of interspecific origin and rootstock varieties included in the State Register of Breeding Achievements of the Russian Federation, approved for use.

The experiments were laid in the fields of the ARRIV&W – Branch of FRARC, Novocherkassk, Rostov region in 2019-2020. The following rootstock varieties were used in the study: Berlandieri × Riparia Kober 5 BB and Riparia × Rupestris 101-14 and scion varieties: Denisovsky, Prestige. The experiments were repeated three times, 50 plants in each. The grafting was carried out according to the generally accepted technology of table grafting with a one-eyed cuttings of a scion on a stock of a standard length (45 cm), maintenance and protective measures are standard for a stratification chamber and an irrigation nursery garden. The assessment of the compatibility of scion-rootstock combinations was carried out in two stages: 1. after stratification of grafts; 2. field conditions. The research technique that allows to assess the compatibility of scion-rootstock combinations in the chamber included the determination of the regenerative activity of grafted grape cuttings by the method of L.M. Maltabar, N.I. Melnik (2004) and callus formation in the average sample of inoculations by the method of L.V. Kolesnikov (1968). After stratification in the chamber, the grafts were hardened for a week before planting in order to prepare the grafts for field conditions. In the middle of the growing season, the nature of survival was determined; in dynamics, the growth and development of seedlings in the nursery garden were taken into account. The development of the root system was assessed by the method of L.V. Kolesnik (1968), and the release of first-class grape seedlings from the nursery garden according to the generally accepted method (in accordance with GOST 31783-2012) was carried out after digging.

3. Results and Discussion

An analysis of the condition of the cuttings before the start of grafting showed that the planting material was free from diseases and pests. The moisture content of the scion cuttings was at the level of 65.0%, of the rootstock - 75.0%. The preservation of central buds in scion cuttings by varieties was: Denisovsky - 68.9%, Prestige - 79.8%. Stratification was carried out on a nutrient substrate for 15-20 days.

According to table 1, it can be seen that, depending on the variety of rootstock, the regenerative activity of grafts differs significantly. The regeneration activity is more active in the rootstock variety Kober 5 BB for the scion varieties Denisovsky and Prestige, where the yield of grafts with circular callus was 90.3 and 72.0%, respectively. The development of ocelli was at the level of 53.3-66.7% with a shoot length of 6.9 to 9.5 cm.

At the time of the planting of vaccinations, Denisovsky × Kober 5 BB had insufficient quality of accretion of scion-rootstock components, and therefore, during transportation, the vaccinations were damaged and the number of planted vaccinations in the nursery garden decreased by 16.3% and amounted to 74.0%. The number of rejected vaccinations of the remaining variants of the experiment varied from 0.4 to 9.9%.

The survival rate of grape seedlings in the nursery garden was determined after the appearance of a tendril on the shoot. According to table 2, it can be seen that on the rootstock variety Kober 5 BB there is a significant decrease in the number of vaccinations at the time of registration. The survival rate of grafts of the Denisovsky variety on the Kober 5 BB rootstock decreased by 24.3%, as well as for the Prestige variety, the decrease was 21.4%. The high percentage of deaths of vaccinations in the nursery garden can be explained by unfavorable external factors. Under prolonged exposure to high
temperature, low humidity and complete absence of precipitation, the Kober 5 BB rootstock is not able to fully develop and provide the scion part with water and nutrients.

Table 1. Yield of vaccinations after stratification (average 2019-2020).

| Experience variant (combination) | Vaccination yield after stratification, % | Average length of shoots, cm |
|---------------------------------|------------------------------------------|-----------------------------|
|                                 | with circular callus | with a developed eye |                   |
| Denisovskiy × Kober 5 BB        | 90.3                      | 53.3                      | 8.6                |
| Denisovsky × Riparia Rupestris 101-14 | 83.6                      | 66.7                      | 9.5                |
| Prestige × Kober 5 BB           | 72.0                      | 56.7                      | 7.8                |
| Prestige × Riparia Rupestris 101-14 | 63.2                      | 53.3                      | 6.9                |

The rootstock of Riparia Rupestris 101-14 showed good development of grafts before planting, ensuring the survival rate on the plantation of 59.3% for the Prestige variety and 73.3% for the Denisovsky variety.

Table 2. Influence of rootstock on survival rate and seedling yield at shkolku (average 2019-2020).

| Experience variant (combination) | Planted vaccinations in a nursery garden, % | The survival rate of vaccinations, % | Saplings yield, % |
|---------------------------------|---------------------------------------------|-------------------------------------|-------------------|
|                                 |                                           |                                     |                   |
| Denisovskiy × Kober 5 BB        | 74.0                                       | 49.7                                | 23.8              |
| Denisovsky × Riparia Rupestris 101-14 | 73.7                                       | 73.3                                | 45.4              |
| Prestige × Kober 5 BB           | 72.4                                       | 51.0                                | 8.1               |
| Prestige × Riparia Rupestris 101-14 | 61.3                                       | 59.3                                | 48.0              |
| HCP05                           |                                            |                                     |                   |

The seedling yield varied significantly from the combination. For the Denisovskiy variety, the yield varied from 23.8 to 45.4% (with HCP05 = 7.7), and for the Prestige variety, from 8.1 to 48.0% (with NRS05 = 3.1). Analyzing the data for both graft varieties, we can conclude that their greatest responsiveness is observed when using the rootstock of the Riparia Rupestris 101-14 variety. The classic rootstock Kober 5 BB shows poor survival and seedling yield, which is possibly due to the peculiarities of agricultural technology.

The influence of the rootstock variety on the onset of the phenophase - vine ripening was established. In combinations with rootstock PP 101-14, an earlier onset of maturation was noted. Figure 1 shows that a large length of the ripened part of 46-48 cm is observed with a combination of scion varieties with a rootstock PP 101-14 with a total length of one-year growth of 84-86 cm. On a Kober 5 BB rootstock, weak maturation of annual shoots of 26-32 cm was the total length of the growth is 63-118 cm (figure 2).

The analyzed indicators show the influence of the stock PP 101-14 on the biometric indicators of seedlings: the diameter of the annual growth of the Denisovskiy variety is 4.3 mm, the Prestige variety is 7.7 cm (table 3). For the Prestige variety, a more powerful development of biometric indicators is observed in comparison with the Denisovskiy variety. The leaf area of the seedlings varied from 1092.8 to 1567.3 cm². The greatest length of one-year growth (118 cm) and leaf area (1567.3 cm²) is observed in the combination Prestige × Kober 5 BB. However, the indicators of maturation (30 cm) and growth diameter (5.7 mm) are significantly lower than on the PP 101-14 rootstock. Insufficient maturation and shoot thickness can adversely affect winter storage and spring planting.
Figure 1. Dynamics of growth and maturation of grafted seedlings depending on the rootstock variety (average for 2019-2020).

Table 3. Biometric parameters of the development of seedlings before digging under the influence of the rootstock (average 2019-2020).

| Experience variant (combination) | Shoot length, cm | The ripening of the shoot, cm | Shoot diameter, mm | Sheet surface area, cm² |
|----------------------------------|------------------|-----------------------------|-------------------|-----------------------|
| Denisovsky × Kober 5 BB          | 63               | 37                          | 4.1               | 1092.8                |
| Denisovsky × Riparia Rupestris 101-14 | 87               | 55                          | 4.3               | 1142.5                |
| Prestige × Kober 5 BB            | 118              | 30                          | 5.7               | 1567.3                |
| Prestige × Riparia Rupestris 101-14 | 84               | 51                          | 7.7               | 1452.4                |

Figure 2. Top-notch grafted grape seedlings of the combination Denisovsky × Riparia Rupestris 101-14 after digging (2019).
When analyzing the root system of grafted grape seedlings, it was noticed that the development of the root system of plants in the nursery garden is closely related to the growth force of the scion variety. All seedlings in the experimental variants had a well-developed root system. The best results were obtained on the Denisovsky variety on Riparia × Rupestris 101-14 rootstock.

4. Conclusion
According to the results of the studies, it can be concluded that the selection of the optimal scion-rootstock for growing the necessary scion varieties has a direct effect on the yield of seedlings, which, with the same level of agricultural technology, will minimize production costs for inoculating seedlings and repairing grape plantations.

According to the research results 2019-2020, it was found that the yield of first-class seedlings of the Denisovsky and Prestige varieties significantly depends on the used rootstock variety. The Riparia Rupestris 101-14 rootstock has the highest yield of seedlings of the Denisovskiy variety, 45.4%, which is 21.6% more than on the Kober 5 BB rootstock variety. On the Denisovskiy variety, the seedling yield was 48.0%, which is 39.9% more than on the Kober 5 BB rootstock variety.

References
[1] Novikova L Yu and Naumova L G 2018 Analysis of economically valuable traits of grape varieties of various origins from the collection of VNIIViV in conditions of climatic changes. Scientific works SKFNTsSVV 19 113-11
[2] Malykh G P, Titova L A, Magomadov A S and Danilov D V 2012 Strategic direction for the development of viticulture on the sands. Increasing the competitiveness of viticulture and winemaking products based on the creation of new varieties and technologies 321 160-166
[3] Grigoriev A A and Avdeenkov I A 2019 Study of the effect of biological preparations on the degree of rooting of grafted grape seedlings. Topical issues of the development of agricultural sectors: theory and practice 22 37-41
[4] Silva M J R, Paivaa A P M, Pimentel A J, Sánchez C A P C, Callili D, Moura M F, Leonel S and Tecchio M A 2018 Yield performance of new juice grape varieties grafted onto different rootstocks under tropical conditions. Scientia Horticulturae 241 194-200
[5] Gautier A, Cookson S J, Lagalle L, Ollat N and Marguerit E Influence of the three main genetic backgrounds of grapevine rootstocks on petiolar nutrient concentrations of the scion, with a focus on phosphorus. OENO One 54(1) 1-13
[6] Oliveira De J B, Laureano O, Castro R, Pereira G E and Ricardo-da-Silva J M 2020. Rootstock and harvest season affect the chemical composition and sensory analysis of grapes and wines of the Alicante Bouschet (Vitis vinifera L.) grown in a tropical semi-arid climate in Brazil. OENO One 54(4) 1021–1039
[7] Renouf V, Trégoat O, Roby J P and Van Leeuwen C 2010 Soils, rootstocks and grapevine varieties in prestigious Bordeaux vineyards and their impact on yield and quality. OENO One 44(3) 127–134
[8] Silva M J R, Paivaa A P M, Pimentel A J, Sánchez C A P C, Callili D, Moura M F, Leonel S and Tecchio M A 2018 Yield performance of new juice grape varieties grafted onto different rootstocks under tropical conditions. Scientia Horticulturae 241 194-200
[9] Jin Z, Sun T, Sun H, Yue Q and Yao Y 2016 Modifications of ‘Summer Black’ grape berry quality as affected by the different rootstocks. Scientia Horticulturae 210 130-137
[10] Kazakhmedov RE 2020 Grapes and phylloxera: the influence of physiologically active compounds on the biochemical characteristics of the root system of grapes. Fruit and viticulture of the South of Russia 66(6) 250-269
[11] Du Y, Zheng Q, Zhai H, Jiang E and Wang Z Selectivity of Phylloxeraviticola Fitch (Homoptera: Phylloxeridae) to grape with different resistance and the identification of grape root volatiles. ActaEntomol. Sinica 52 537-543
[12] Kazakhmedov R E 2019 Physiological aspects of increasing the tolerance of grapes to root
phylloxera. *Agrochemistry* **6** 18-26

[13] Di Filippo M and Hernán V 2011 Influence of different rootstocks on the vegetative and reproductive performance of *Vitis vinifera* L. Malbec under irrigated conditions. *Journal International des Sciences de la Vigne et du Vin* **45** 75-84

[14] Batukaev A A, Malykh G P, Magomadov A S, Batukaev A A and Seget O L 2019 New technological solutions for the production of planting material of grapes. *Journal of environmental treatment techniques* **T 7** 4 581-587

[15] Vršič S, Pulko B and Kocsis L 2015 Factors influencing grafting success and compatibility of grape rootstocks. *Scientia Horticulturae* **181** 168-173