Selection of variety and length of grape rootstock when growing grafted seedlings

L A Titova1 and I A Avdeenko2

1 The Chechen State University, 32, Sheripova street, Grozny, 364907, Russia
2 All-Russian Research Institute named after Ya.I. Potapenko for Viticulture and Winemaking – Branch of "Federal Rostov Agricultural Research Center", 166, ave. Baklanovsky, Novocherkassk, 346421, Russia

E-mail: larisa-titova-1976@mail.ru

Abstract. The industrial culture of grapes necessitates the formation of highly productive plantations. The grafted culture of grapes, in comparison with the own-rooted one, solves a number of problems of industrial viticulture. However, the increased costs for the production of grafted seedlings in comparison with own-rooted ones necessitate a reduction in the cost of their production, which can be achieved by reducing the length of the underground stem, and obtaining the greatest amount of yield can be achieved by choosing the right rootstock variety. An analysis of current research showed a lack of knowledge of this issue, which served as the basis for setting up research that was carried out from 2019 to 2020 in the fields ARRIV&W named Ya.I. Potapenko (branch of FRARC). The aim of the research was the selection, for grafted seedlings of the Prestige grape variety, of the optimal length and variety of the rootstock, with an assessment of the impact on biometric indicators. The rootstock variety had the greatest influence on the quality of seedlings. In the variant with the rootstock variety Kober 5 BB, the final yield of seedlings was low and varied from 8.1 to 37.2%. A significant increase in the yield of seedlings was observed when using the rootstock variety Riparia Rupestris 101-1, which varied from 30 to 48%, which is 1.3-3.7 times more than when using the rootstock Kober 5 BB. In addition to significant differences in the options when choosing a rootstock variety, according to the results of the research, there was a tendency to increase the final yield of seedlings with a decrease in the length of the rootstock from 45 cm (standard length of the rootstock) to 30 cm for both varieties.

1. Introduction

The quality of the grafted material determines the durability and productivity of grafted vine plantations. It should be understood that plantations planted with low-quality material may not meet the expectations placed on them (variegated yields on individual bushes, sparseness of plantations, low profitability and early old age of plants) [1-6].

Obtaining high-quality grafted material that meets the standards in terms of length, thickness and maturation time largely depends on the quality of the agrotechnological care work. In this regard, the complex of ongoing works and activities should be aimed at obtaining healthy and strong bushes of a grape plant, ensuring good maturation of the vine, by the time the cutting is harvested [7-9].

The Rostov region belongs to the territories prone to phylloxera infection. This pest is one of the most dangerous and belongs to quarantine. All physiological processes of phylloxera occur only on the...

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd
vine (on one or another organ, the root system suffers the most). American rootstock varieties tolerate phylloxera infection more easily, which makes their use more reasonable [7;10-13].

In some areas it is possible to grow grapes in their own root culture, however, in this case, it is necessary to observe many agro-technological measures to minimize the harmful effects of phylloxera. According to a number of researchers, the grafted culture is more promising in areas prone to phylloxera infection (the percentage of fruitful shoots is higher, the absence of necrosis, a number of physiological and biochemical processes are more intense than in the native root culture) [11;13-15].

Also, do not forget that some manufacturers of grafted planting material do not take into account the affinity between scion and rootstock, because of which the bushes of the future plant will be doomed to low profitability and low durability [16-20].

2. Materials and methods
The experiments were laid in 2019 and 2020 in the fields of ARRIV&W named Ya.I. Potapenko (branch of FRARC, Novocherkassk, Rostov region). The soil of the experimental plot is represented by ordinary chernozem, medium-thick, with deep occurrence of ground wons, continental climate, with a sum of positive temperatures of 3300 °C. The region belongs to the zone of risky farming due to insufficient moisture. During the years of research, climatic conditions varied greatly, which made it possible to more comprehensively assess the effect of the length and variety of the rootstock when growing grafted seedlings of the Prestige grape variety. The air temperature during the growing season of vaccinations on shkolka averaged about the same over the years, however, the average monthly temperatures from April to May exceeded the average annual values, and the sum of active temperatures on average exceeded the average annual values by 300 °C. The distribution of precipitation during the years of research varied significantly. In 2019, May was characterized by cold weather and excessive moisture (63 mm), and in the summer months, the amount of precipitation varied from 12.2 to 31 mm, with long-term averages of 41.1-59.7 mm. In 2020, May was characterized by temperature and precipitation at the level of long-term averages. The amount of precipitation in the summer months of 2020 was higher than in 2019, but significantly below the norm.

The aim of the research was the selection, for grafted seedlings of the Prestige grape variety, of the optimal length and variety of the rootstock, with an assessment of the impact on biometric indicators. The repetition of experience 3-fold. The number of plants in repetition 50 pcs. In the experiment, the affinity of the graft grape variety Prestige with two varieties of rootstock (Kober 5 BB; Riparia Rupestris 101-14 (hereinafter 101-14)) of various lengths was studied: 1. - a rootstock 45 cm long (the generally accepted length of the rootstock when conducting table vaccination); 2. - rootstock 40 cm long; 3. - stock 35 cm long; 4. - rootstock 30 cm long.

The technology for the production of grafts is generally accepted for table grafting (one-eyed stalk of the graft variety). The stratification of the grafts was carried out for 21 days in a chamber with forced ventilation under optimal conditions of humidity and air temperature for the fusion of the graft components. The cultivation of grafted cuttings was carried out on an irrigated school with the use of generally accepted care work, plant protection products and fertilizers. The objectives of the research included: analysis of the regenerative activity of cuttings; callus formation of grafts during and after stratification; taking into account the survival rate and the yield of seedlings; analysis of biometric parameters; the degree of development of the root system. In the text, research data are presented in average values for 2019-2020.

3. Results and Discussion
Figure 1 clearly reflects the influence of the length and variety of the rootstock on the fusion of the graft components after stratification. Best of all, circular callus formation of the graft variety Prestige was noted with a length of 40 cm of rootstock 101-14 (80%). The classic rootstock variety Kober 5 BB was slightly inferior, where the yield was the highest (76%) with a significant reduction in the length of the rootstock to 30 cm.
So, with a rootstock length of 30 cm of variety 101-14, a decrease in the complete fusion of the graft components by 50% is observed, which is less than the variant with the generally accepted length (45 cm) by 13.2%, with an increase in the percentage of grafts with a full-blown eye to 86.7%. The studied variants of the length of the rootstock variety Kober 5 BB were at the same level according to the analyzed indicators.

Figure 1. Influence of rootstock length and variety on the quality of grafting variety Prestige after stratification.

![Figure 1](image1.png)

Figure 2 clearly shows the significant influence of the rootstock variety on the adaptive performance of grafting. After stratification, the yield of grafts in variety Kober 5 BB varied from 70.3 to 75.4%. The rootstock variety 101-14 showed itself ambiguously. In variants with a rootstock length of 45 and 35 cm, the yield of grafts from the chamber was 63.2%, while in other variants it was 16.8–23.5% higher. There is a general tendency to increase the yield of grafts with a decrease in the length of the rootstock.

Figure 2. Adaptation of grafting varieties Prestige when grown on shkolka.
Figure 2 also confirms the positive dependence of the decrease in the length of the rootstock on the survival rate of vaccinations in the school, which was taken into account a month after planting. The highest survival rate of grafted cuttings was noted when using a rootstock of variety 101-14 30 cm long, which amounted to 80.9%, which is 40.9% more than with the same length of rootstock of variety Kober 5 BB. Intermediately, it can be noted that the rootstock variety Kober 5 BB responds negatively to a decrease in the length of the rootstock, which reduces the survival rate of seedlings on a shkolka, which directly affects the final yield of seedlings, which varied from 8.1 to 37.2%. The rootstock variety 101-14 was distinguished by good adaptive parameters, proving the need for the correct selection of the rootstock variety for the soil and climatic conditions of the place of cultivation and the scion variety. Intermediately, it can be noted that the rootstock variety 101-14 responds positively to a decrease in length for the graft grape variety Prestige, in which the survival rate of seedlings on shkolka is at the level of 62.3-80.9%. The yield of seedlings in variants with the rootstock variety 101-14 varied from 30 to 48%, which is 21.9-39.9% more than the second rootstock variety used in the experiments.

![Prestige × Kober 5 BB](image1)

![Prestige × Kober 5 BB](image2)

Figure 3. Grape seedlings in 2020 depending on length and variety (2020).

Differences in the degree of development of the root system from the length and variety of the rootstock are clearly shown in Figure 3. The root system of the Kober 5 BB (45 cm) rootstock was underdeveloped, but sufficient for further planting in a permanent place. Reducing the length of the rootstock to 30 cm stimulated the development of heel and middle roots, vertical, horizontal orientation. The root system of rootstock 101-14 was more developed in all variants, a significant thickening of the heel of the seedling and the formation of dew roots were noted. When growing grafted seedlings on a shkolka, the development of powerful heel, middle, and dew plants is an important physiological indicator that ensures better survival of plants when planted in a permanent place.

Large losses on all variants of the Kober 5 BB rootstock allowed the surviving seedlings to minimize competition for nutrients, moisture, and light, which stimulated the development of the above-ground part of the seedlings, which is confirmed by the data presented in table 1.
Table 1. Indicators of the development of annual shoots of seedlings of the Prestige variety at different lengths and rootstock varieties.

| Rootstock variety | Rootstock length, cm | Shoot length, cm | Shoot maturation, cm | Runaway diameter, mm | Leaf surface area, cm² |
|-------------------|----------------------|------------------|----------------------|----------------------|------------------------|
| Kober 5 BB        | 45                   | 118              | 28                   | 5.7                  | 1567.3                 |
|                   | 40                   | 183              | 39                   | 8.3                  | 2448.1                 |
|                   | 35                   | 92               | 38                   | 5.4                  | 1712.0                 |
|                   | 30                   | 188              | 23                   | 7.4                  | 3165.1                 |
| Riparia Rupestris | 45                   | 84               | 44                   | 7.7                  | 1452.4                 |
| 101-14            | 40                   | 113              | 55                   | 6.8                  | 1912.9                 |
|                   | 35                   | 116              | 45                   | 6.5                  | 1782.2                 |
|                   | 30                   | 114              | 27                   | 7.4                  | 1707.6                 |

The best development of biometric indicators of seedlings was noted on the rootstock variety Kober 5 BB, which is confirmed by the data in Table 1. Depending on the options, the length of one-year growth varied from 92 (rootstock length 35 cm) to 188 cm (rootstock length 30 cm), with the development of a powerful leaf apparatus with an area from 1567.3 (rootstock length 45 cm) to 3165.1 cm² (rootstock length 30 cm). Despite the powerful development of shoots, the degree of maturation is the most important physiological indicator. The ripening of seedling shoots on the rootstock variety Kober 5 BB varied from 12 to 41% in relation to the length, which is significantly less than on the rootstock variety 101-14, where the ripening varied from 24 to 52%. Analyzing the influence of the rootstock variety on biometric indicators and the quality of the shoots, the best responsiveness of the graft variety Prestige to the rootstock variety 101-14 was noted.

4. Conclusion
As a result of two years of research, it can be concluded that the Prestige grape variety, when propagated by table grafting, shows the best affinity with the rootstock variety Riparia Rupestris 101-14. The length of the rootstock also has a significant impact on the yield of grafted seedlings of the variety. According to the research results, the highest seedling yield of 48% was obtained in the variant with a 40 cm long rootstock variety Riparia Rupestris 101-14, which is 7.5% more than the generally accepted rootstock length in the production of grafted seedlings (45 cm), and more than the generally accepted length of the common classic rootstock variety Kober 5 BBs 45 cm long by 39.9%.

References
[1] Novikova L Yu, Travina S N, Zhigadlo T E, Naumova L G and Zuev E V 2015 Quality of agricultural crops on the European territory of the Russian Federation under climate change. Proceedings on applied botany, genetics and breeding 176(4) 391-401
[2] Vršič S, Pulko B and Kocsis L 2015 Factors influencing grafting success and compatibility of grape rootstocks. Scientia Horticulturae 181 168-173
[3] Novikova L Yu, Dyubin V N, Loskutov I G, Zuev E V, Kovaleva O N, Porokhovinova E A, Seferova I V, Bulyntsev S V, Artem'eva A M, Kiru S D, Rogozina E V and Naumova L G 2013 Analysis of the dynamics of economically valuable traits of crop varieties under climate change. Proceedings on Applied Botany, Genetics and Breeding 173 102-119
[4] Silva M J R, Paiva A P M, Pimentel A J, Sánchez C A P C, Callili D, Moura M F, Leonal 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] Tecchio M A, Silva M J R, Callili D, Hernandez J L and Moura M F 2020 Yield of white and red grapes, in terms of quality, from hybrids and Vitis labrusca grafted on different rootstocks. Scientia Horticulturae 259 108846
[6] Bidabadi S S, Afazel M and Sabbatini P 2018 Iranian grapevine rootstocks and hormonal effects on graft union, growth and antioxidant responses of asgari seedless grape. Horticultural
Plant Journal 4(1) 16-23

[7] Titova L A, Magomadov A S, Avdeenko I A and Grigoriev A A 2021 Development of grafted grape seedlings depending on the length and variety of rootstock. IOP Conf. Series: Earth and Environmental Science 723 022085

[8] Borisenko M N and Belinsky Yu A 2013 Yield of standard stock cuttings Berlandieri x Riparia Kober 5BB depending on the planting pattern and formation of "Magarach" mother bushes. Viticulture and winemaking 4 8-10

[9] Borisenko MN and Belinskiy Yu A 2017 Yield of grafted vine seedlings in shkolka and their quality depending on the management system of the mother liquor of rootstock vines "Magarach". Viticulture and winemaking 4 30-32

[10] Ivanchenko V I, Zotikov A Yu and Smychkova S A 2018 The influence of variety-rootstock combinations on the yield and quality of grafted cuttings and seedlings of grapes. "Magarach". Viticulture and winemaking 1 12-15

[11] Petrov V S and Pavlyukova T P 2018 Establishment of embryonic inflorescences and realization of the potential of economic productivity in grape varieties in the temperate continental climate of the South of Russia. Agricultural biology 53(3) 616-623

[12] Novikova L Yu and Naumova L G 2020 Dependence of fresh grapes and wine taste scores on the origin of varieties and weather conditions of the harvest year in the northern zone of industrial viticulture in Russia. Agronomy 10(10) 1613

[13] Novikova L Yu and Naumova L G 2019 Structuring the ampelographic collection according to phenotypic characteristics and comparing the response of grape varieties to climate change. Vavilov Journal of Genetics and Breeding 23(6) 142-149

[14] Novikova L Yu and Naumova L G 2018 Analysis of economically valuable traits of grape varieties of various origins from the collection of VNIIViV under conditions of climate change. Scientific works of SKFNTsSVV 19 113-119

[15] Naumova L G and Ganich V A 2014 Preservation of the gene pool of native Don grape varieties. Works on applied botany, genetics and breeding 175(4) 13-17

[16] Arestova N O and Ryabchun I O 2017 Grape phylloxera Plant protection and quarantine 2 34-36

[17] Tekueva M T, Burkov A V, Nosov V V, Novoselova S A and Nayanov A V 2016 Agriculture and agribusiness: Clustering issues. Research Journal of Pharmaceutical, Biological and Chemical Sciences 7(6) 1634-1638

[18] Nikiforov A, Kuchumov A, Terentev S, Karamulina I, Romanova I and Glushakov S 2020 Neural network method as means of processing experimental data on grain crop yields E3S Web of Conferences 161 01031

[19] Zhichkina K, Nosov V and Zhichkina L 2019 Economic mechanism of the machine-tractor park updating in the samara region. IOP Conference Series: Earth and Environmental Science 403(1) 012073

[20] Ermakova A M 2021 Features of introduction of innovative means in production activity of the agricultural enterprise. IOP Conference Series: Earth and Environmental Science 723(3) 032070