Advanced seedless donors among grape varieties of the Anapa zonal experimental station for grape growing and wine making (AZESGGAWM) selection

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Abstract. The share of seedless grape varieties in the total grape production in the country is very small. Of the 106 table varieties included in the register, only 4 are seedless grape varieties (Kishmish Luchistiy, Korinka Russkaya, Yuzhnoberzhyi, Yaltinsky Bessemymanniy). These varieties are very much in demand, as their berries are used both fresh and dried. This article shows the results of multi-year research on the identification of seedless genetic donors among grape varieties of the selection of the Anapa Zonal Experimental Station for Grape Growing and Wine Making, such as Lotos, Zhemchug Anapy and Kishmish Rozovy AZOS. In the frame of this study, agronomic characters and annually changing weather conditions were studied side by side. In addition, an assessment of these varieties was carried out in terms of the intensity of the seedless character in the conditions of the Anapa-Taman grape growing zone. The largest mass of rudiments in all the analyzed samples was found in the Kishmish Rozovy AZOS variety; therefore, it was assigned to the third category of seedless grape, although the ratio of the rudiment mass to the berry mass is negligible. The rest of the studied seedless grape varieties in comparison with the control variety (Kishmish Luchistiy) have a higher seedless class. In particular, this concerns the varieties – Zhemchug Anapy and Lotos belonging to the first and second seedless class, respectively. At the same time, yield of these varieties and their productivity (fruit-bearing and fruitfulness coefficients) together with plant development phenology depending on weather conditions were studied for several years. In particular, it was found that annually high productivity indicators are observed in all the studied varieties, as well as high yields are observed every year in the varieties Lotos and Zhemchug Anapy. This article presents the results of these studies from 2017 to 2019. The work performed showed the prospect of using productive, resistant to biotic and abiotic environmental factors with a high seedless category of grape varieties of the AZESGGAWM selection as future seedless donors.

1. Introduction

One of the most important problems in the selection of grape culture is the improvement of the table grape assortment with new varieties that are characterized by early ripeness, large berries, good taste, high yield, resistance to adverse environmental conditions, as well as absence of seeds [1, 2].
In the State Register of Selection Achievements Approved for Use in the territory of the Russian Federation for 2019, it is registered a total of 272 grape varieties, including 136 technical, 106 table and 30 universal varieties [3]. There is a small number of seedless (kishmish) grape varieties in the total volume of production in our country [4]. There are only four seedless varieties (Kishmish Luchistiy, Korinka Russkaya, Yuzhnoberezhniy, Yaltinskiy Besemyanni) among the 106 table grape varieties included in the register [5]. Globally there is an annual increase in consumer demand for seedless grape varieties, as their berries are used both fresh and dried [6]. Therefore, breeders face an important task of the breeding of new seedless grape varieties, which in its turn is aimed at improving the grape growing efficiency [7-11]. A prerequisite for obtaining a new seedless variety is the selection of seedless donors among the existing or recently obtained seedless grape varieties [12-16]. For example, AZESGGaWM experts carry out studies of seedless grape varieties created in recent years, such as Kishmish Rozovy AZOS, Lotos, Zhemchug Anapy [17, 18].

2. Objects and methods
The objects of this study are table seedless grape varieties of the selection of the Anapa Zonal Experimental Station for Grape Growing and Wine Making: Kishmish Rozovy AZOS, Lotos, Zhemchug Anapy. Work on the study of seedless grape varieties was carried out according to modern and generally accepted methods [19-22]. Varieties were studied in open-earth culture, grafted on a Kober 5BB rootstock. The bushes management system is high standard, the forming of bushes is “Spiral cordonAZES-1”, the spacing is x3.5 x 2.0 m, the soil is southern chernozem, weakly leached, slightly humus, powerful, heavy loamy granulometric composition, formed on heavy loess soil.

The aim of the research work was to identify future candidate seedless donors among the grape varieties of the AZESGGaWM selection, as well as to study the dynamics of their agronomic characters in connection with changing weather conditions.

3. Results and discussion
In recent years’ experts of the Anapa Zonal Experimental Station for Grape Growing and Wine Making have been creating valuable table seedless grape varieties, such as Kishmish Rozovy AZOS, Lotos, Zhemchug Anapy. These varieties combine high productivity, absence of seeds, large and medium size of berries, high commercial and taste qualities.

Kishmish Rozovy AZOS (Kriulyansky x Yangi Er) [Russia, AZESGGaWM] - a grape of medium ripening. Androgenous bloom. The clusters are very large, loose, cylindrical-conical in shape. The mass of a cluster is on the average 520 g, but it can reach up to 2 kg. The berries are large, oval, pink, almost transparent, with an average weight of 4 g. The peel is thin. The pulp is juicy-fleshy, melting, seedless (figure 1).

![Figure 1. Grape variety Kishmish Rozovy AZOS (2019).](image1)

![Figure 2. Lotos grape variety (2019).](image2)
Fruitfulness coefficient is 1.2. Productivity is 120-140 centner/hectare. Sugar content is 19-20 g/100 cm³, acidity is 6 g/dm³. Average shipping quality. Increased resistance to fungal diseases and pests. Average frost resistance. Tasting score of fresh grapes is 9.0 points. Suitable for consumption in the fresh form, as well as for making jam and for drying.

Lotos (Kriulyansky x Yangi Er) [Russia, AZESGGaWM] - a grape of early ripening. Androgenous bloom. The clusters are large and medium, laticonic form, with an average weight of 380 g. The berries are medium, seedless, oval, pink. The peel is thin but strong. The pulp is juicy-fleshy. The taste is pleasant. Sugar content at mature stage is 18-20 g/100 cm³, acidity is 7 g/dm³. The growth of shoots is average, the fruitfulness coefficient is 1.3 (figure 2).

Productivity of this variety is 120-140 centner/hectare. Increased resistance to fungal diseases and frost. Low shipping quality. Tasting score of fresh grapes is 8.8 points. The Lotos is suitable for fresh local consumption, as well as for drying.

Zhemchug Anapy (Kriulyansky x Yangi Er) [Russia, AZESGGaWM] - a grape of medium ripening. Androgenous bloom. The clusters are large and medium, loose, with an average weight of 465 g. The berry is medium, weighing 4 g, seedless, round, white. The peel is strong. The pulp is juicy-fleshy. The taste is balanced. Sugar content is 18-20 g/100 cm³ with acidity of 7.2 g/dm³. Increased resistance to fungal diseases, pests and frost. Average shipping quality. This variety is suitable for fresh local consumption, as well as for drying (figure 3).

The long-standing, well-studied seedless grape variety Kishmish Luchistiy (Cardinal x Kishmish Rozovy) was chosen as a control variety (figure 4).

Grape variety of early-medium ripening. Androgynous bloom. The clusters are large and very large (up to 620 g), medium density. The berry is elliptical, large, pink with juicy-fleshy pulp and a simple taste. Sugar content is 18.0 g/100 cm³ with acidity of 6.0 g/dm³. Fruit-bearing coefficient is 0.81, fruitfulness coefficient is 1.42. Productivity is 10.54 kg per bush. Increased resistance to oidium. This variety is also used for fresh consumption, as well as for drying. The above data on the morphology description of generative organs, productivity indicators, yield, etc. among the studied seedless grape varieties annually change due to changing weather conditions [23].

According to the weather base Pessl (N: 37.426385º; E: 44.910412º) located on the territory of the Anapa ampelographic collection, it was found that the conditions of the winter periods from 2017 to
2019 were different. In particular, the winter periods of 2018-2019 were atypically almost frost-free compared to the previous one. For example, minimum temperature in January 2017 was -3.2°C (figures 5-7), while minimum temperature in January 2018 was +1.7°C, and in 2019 – +2.7°C. The spring of 2018 and 2019 can be described as moderately warm compared to the spring of 2017.

Figure 5. Dynamics of temperature conditions and precipitation, 2017 (weather base Pessl, Anapa district).

Figure 6. Dynamics of temperature conditions and precipitation, 2018 (weather base Pessl, Anapa district).

Figure 7. Dynamics of temperature conditions and precipitation, 2019 (weather base Pessl, Anapa district).
The average monthly air temperature in March 2017 was 6.1°C, in March 2018 – 6.8°C, and in March 2019 – 8.1°C, which slightly exceeds the annual average values by 2°C and 0.6°C in 2017 and 2018 respectively, and which is slightly lower than the norm in 2019 (by 0.7°C).

There amount of precipitation in March 2017 was 1.2 times above the norm, in 2018 – 1.6 times above the norm, and in 2019 precipitation was 1.3 times less than the norm. The beginning of sap flow in the studied grape varieties in 2017 began from the 1st decade of March, in 2018 – from the second decade, and in 2019 – in the third decade of March (table 1).

Table 1. Phenological indicators of seedless grape varieties of AZOS selection for 2019.

| Phenological phase                     | Varieties                |
|----------------------------------------|--------------------------|
|                                        | Lotos                    | Zhemchug Anapy | Kishmish Rozovy AZOS | Kishmish Luchistiy |
| The beginning of bleeding              | 23.03                    | 24.03          | 24.03                | 26.03              |
| The beginning of bud pushing           | 12.04                    | 17.04          | 13.04                | 18.04              |
| beginning                              | 29.05                    | 31.05          | 31.05                | 29.05              |
| Blossom                                | 02.06                    | 04.06          | 04.06                | 01.06              |
| large-scale end                        | 05.06                    | 08.06          | 10.06                | 07.06              |
| Ripening of berries                    | 28.07                    | 31.07          | 01.08                | 21.07              |
| beginning                              | 10.08                    | 13.08          | 14.08                | 01.08              |
| complete                               |                          |                |                      |                    |
| Beginning of the one-year shoots       | 19.07                    | 03.08          | 02.08                | 01.08              |
| ripening                               |                          |                |                      |                    |
| The number of days from the            | 121                      | 129            | 130                  | 122                |
| beginning of bud pushing to full       |                          |                |                      |                    |
| physiological maturity                 |                          |                |                      |                    |
| The beginning of defoliation           | 20.10                    | 24.10          | 24.10                | 24.10              |

The temperature crossed threshold value of +10°C mark in 2017 from the third decade of March, in 2018 – from the second decade, and in 2019 – from the end of the first decade of March. The average monthly temperature in April in 2017 was 9.8°C, which is 1.2°C lower than the norm, in 2018 the average monthly temperature in April – 13.5°C, which is 3.4°C higher than the norm, and in 2019 – 10.4°C, which is below the norm by 0.7°C. Precipitation in April 2017 – 77.2 mm (38.2 mm higher than the norm), in April 2018 – 13.8 mm (25.7 mm lower than the norm), and in April 2019 – 16.6 mm (22.9 mm below the norm).

Despite the difference in spring weather conditions of 2017-2019, the shooting of eyes in all the studied varieties in these years was observed in the second decade of April. At the same time, the percentage of eyes shooting in 2017 and 2018 was higher than the average value for the Lotos variety - 79.4% and 70.4%, respectively, this value was higher for the variety Kishmish Rozovy AZOS - 78.8% and 90%, as well as Zhemchug Anapy – 78.8% and 93.6% (Zhemchug Anapy). The highest value was observed for the control variety Kishmish Luchistiy – 81.2% and 100%. In 2019, the percentage of eyes shooting in the studied grape varieties was higher than in previous study years: Lotos – 94.6%, Zhemchug Anapy – 100%, Kishmish Rozovy AZOS – 85.8%, control – 95.5%.

May in the studied years was warm and without frost. The average monthly temperature, for example, in 2018 exceeded the annual average value by 3.3°C, and in 2019 it was even higher. At the same time, the maximum air temperature in May 2018 reached 29.5°C, and in May 2019 it reached the level of 31.8°C. In May 2017, more precipitation was noted in the second decade (65.8 mm, 100% of the norm), and in 2018 and 2019 precipitation was noted more in the first decade (also 100% of the norm).

Blooming of the studied varieties began at about the same time – at the end of the third decade of May (29-31 May). The ripening of berries started at the end of the third decade of July and in the first days of August, which is a week later in comparison with the control variety.
In June 2017 hot weather was observed with a minimum amount of precipitation (4.6 mm), while the maximum air temperature had reached 31.7°C. June 2018 was characterized by hot weather, there was practically no precipitation this month (1.2 mm, 3.5% of the norm). The maximum air temperature reached 34.2°C. In June 2019 the weather was also hot, with the maximum temperature of 31.8°C. But precipitation in 2019, in comparison with the previous studied years, was 60.4 mm, which is 16.4 mm higher than the norm.

In July 2017 a slight decrease in the temperature behavior was observed. The average monthly air temperature was 23.4°C, the norm is 24°C. Precipitation was 85.4 mm more than the norm (114.4 mm while the norm is 29 mm), and most of the precipitation occurred in the second decade. July 2018 temperature behavior was slightly warmer and there was no precipitation until the middle of the second decade. The average monthly air temperature was 25.3°C, while the norm is 23.2°C. Precipitation occurred from July 15 to July 28 in the form of heavy rains. In July 2019, as well as in 2017, a slight decrease in the temperature behavior was observed. The average monthly air temperature was 21.9°C, the norm was 24.2°C. Precipitation was in the form of heavy rains mainly in the first decade, and the amount of precipitation was 29.5 mm above the norm. August 2017 - 2019 had abnormally hot and almost dry weather. In August 2017 the amount of precipitation was by 16.6 mm less than the norm, in 2018 it was only 3.2 mm with a norm of 27 mm, and in 2019 it was slightly more than in the previous year. The average monthly air temperature of 2017 and 2018 was 2.5°C above the norm. As a result, the sum of active temperatures for the seasons of 2017-2019 averaged 4220°C, which significantly exceeded the long-time average annual indicator.

Identification of genetic seedless donors among grape varieties should be carried out along with a comprehensive study of agronomic characters.

According to agrobiological registers, the productivity indicators of the studied grape varieties are high in comparison with the control variety Kishmish Luchistiy (State Institute of Grape Growing and Wine Making of the Republic of Moldova). The dynamics of some productivity indicators is presented in the diagrams (figures 8, 9).

![Figure 8](image_url)

**Figure 8.** Dynamics of the fruit-bearing coefficient of seedless grape varieties of the AZOS selection.
A comprehensive assessment of seedless donors among grape varieties of the AZES selection also took into account the calculated yield per hectare (figure 10).

Work on seedless category determination among seedless varieties of the AZESGGaWM selection was carried out (table 2).

**Figure 9.** Dynamics of the fruitfulness coefficient of seedless grape varieties of the AZES selection.

**Figure 10.** Dynamics of the calculated yield per hectare among seedless grape varieties of the AZES selection.

**Table 2.** Seedless level of grape varieties of the AZESGGaWM selection.

| Variety name                  | Average mass of berries, g | Ratio of rudiment mass to the mass of a berry, mg | Rudiment mass in a berry, mg | Seedless category |
|-------------------------------|----------------------------|-----------------------------------------------|-----------------|------------------|
As a result, it was found that the ratio of the rudiment mass to the mass of a berry was less than 1% for the studied grape varieties. And the seedless categories are higher than that of the control variety. In particular, the Zhemchug Anapy variety belongs to the first seedless category, the Lotos variety belongs to the second category and the Kishmish Rozovy AZOS variety belongs to the third seedless category.

Thus, the studied varieties can be recommended as seedless sources for further breeding work. In addition, for many years these varieties have high indicators of productivity, yield and resistance to biotic and abiotic environmental factors.

4. Conclusion
Seedless grape varieties of the AZESGGaWM selection were studied in terms of a number of the agronomic characters with the aim of assessing these varieties by the intensity of the seedless character in the Anapa-Taman grape growing zone. All studied varieties showed almost complete absence of rudiments in berries. The largest mass of rudiments in all the analyzed samples was found in the Kishmish Rozovy AZOS variety; therefore, it was assigned to the third category of seedless grape, although the ratio of the rudiment mass to the berry mass is negligible. The rest of the studied seedless grape varieties in comparison with the control variety (Kishmish Luchistiy) have a higher seedless class. In particular, this concerns the varieties—Zhemchug Anapy and Lotos belonging to the first and second seedless class, respectively. At the same time, yield of these varieties and their productivity (fruit-bearing and fruitfulness coefficients) together with plant development phenology depending on weather conditions were studied for several years. In particular, it was found that annually high productivity indicators are observed in all the studied varieties, as well as high yields are observed every year in the varieties Lotos and Zhemchug Anapy. This article presents the results of these studies from 2017 to 2019. The performed work showed the prospect of using productive, resistant to biotic and abiotic environmental factors grape varieties with a high seedless category of the AZESGGaWM selection as future seedless donors. These are the most valuable varieties for further breeding work.

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