Complex assessment of prospects for cultivation of ultra-early and very early ripening table grape varieties in the Crimea

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Abstract. The results of comparative analysis of phenology, agrobiology, growth vigor, yield and quality characteristics, and uvological indicators of ultra-early and very early ripening table grape varieties are presented. Environmental distance of Crimean agro-climatic conditions and the genetic potential of varieties make it possible to increase the productivity of Crimean vineyards, as well as to cultivate the varieties of ultra-early and very early ripening. The purpose of the work is a comparative description of agro-biological and economic characteristics of table grape varieties in different cultivation areas, and an assessment of their prospects for the Crimea. Based on the methodology developed at the Magarach Institute, the uvological and agrobiological indicators of the studied varieties were studied. Shipping quality of the studied table grape varieties in two zones of cultivation is assessed on the basis of field-proven methodology. Better shipped grape varieties with a high transportability coefficient (T1 - from 80% to 100%) were identified depending on the ripening period. Index values of potential prospects (IPP) for the studied varieties were calculated, being in the range from 0.58 to 0.84. The results obtained are a basis to be used in establishing new plantings and providing a continuous-production line with new table grape varieties of all ripening periods with a high IPP.

1 Introduction

Grape cultivation is an important budget-replenishing income source in the Republic of Crimea. Among the Russian Federation federal member states, the Crimea is the third territory by the area under vineyards (14.9%). Table grape varieties occupy 14.6% of the total area of Crimean vineyards. Market analysis shows that the production of local table grape varieties does not cover consumption needs. With the annual production of table grapes, the Crimeans fall short in 10.2 kg of grapes per year (with a medical standard of consumption 13.6 kg/year). Import of table grapes to the Crimea from Turkey, Chile, Moldova and Armenia is 80%.

In the Russian Federation, 80 table grape varieties were included in the State Register of Breeding Achievements Authorized for Use in 2014. Only 16 varieties out of the total number were in the assortment of Crimea. Now there is a tendency to increase the assortment

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of table grape varieties. Their total number is already 93, and 31 varieties in the assortment of Crimea.

The proportion of ultra-early and very early ripening table varieties a growing season that is less than 120 days long is 31.5% of the total area occupied by grapes in the Crimea.

There is a possibility to increase the productivity of vineyards and increase quality of grape production in the region with the entry of new table cultivars, hybrid forms and introduced varieties. Taking into account diverse agro-climatic conditions of the Crimea, it is necessary to study agro-biological and economic indicators of table grape varieties, varied in accordance with the area of their cultivation, and to assess if they are suitable for a particular zone of viticulture [1, 2].

There are many methods to evaluate table grape varieties: in accordance with climatic, agro-biological, economic, commercial and other indicators. To determine the relationship between environmental requirements and biological reactions of grapes, such climatic indices as solar index, bioclimatic index, heat summation index, latitude-degree temperature index, hydrometric index and drought index are used [3]. Basic factors contributing to the profitable production of grapes, for example, in India, are the selection of varieties and rootstocks for specific areas, introduction of micro-irrigation and fert-irrigation methods, step-by-step pruning, technological interventions, recommendations based on weather forecasts, etc. [4].

Competitive product in the global market is a subject of study of ampelographic, physicochemical and technological characteristic features of grape varieties to identify their adaptive properties and select a particular cultivating area [5, 6].

The researchers Santos Ana, Laranjo Marta, Ricardo Rodrigues Sara (2021), Krasokhina S.I. (2021), as well as Kulzhanov Shokan, Kazybayeva Saule, Tazhibaev Tolepbergen, Azhittaeva Laura, Yessenaliyeva Maira (2022) refer to the commercial assessment of table grape varieties, and also compare scientific data on the climate change with the characteristics of agrobiology, phenology, uvology, and use directions [7-9].

The analysis of mechanical composition and properties of table grapes is suitable for assessing agricultural practices that affect the quality and directions of yield consumption [10-12].

Such researchers as Necula Cezarina, Camelia Popa, Matei Viorica, Iordache Stefania and Stirbu Clara (2010) studied the adaptive properties of table grape varieties [13]; morphological and agro-biological characteristics [14]; agro-biological and economic potential of introducing new table varieties into the assortment [15]; assessment of frost resistance, potential fertility and crop quality of table grape varieties in the conditions of their cultivation [16]; agro-biological characteristics of kishmish grape varieties, mechanical and biochemical composition, technological indicators, and organoleptic evaluation [17].

Thus, scientists all over the world tend to study agro-biological, economic characteristics of table grape varieties in various areas of their cultivation and assess their prospects, as presently relevant for Crimean scientists and Crimean viticulture industry in a whole.

Import substitution of table grapes in the Crimea and Russian Federation requires the selection and promotion of the most valuable varieties, based on the application of a whole range of criteria for assessing agro-biological, economic and commercial indicators, which is the subject of this article.

2 Materials and Methods

Experimental studies were carried out during 2015-2020 in the Crimean production vineyards, analytical studies - in the Laboratory of Grape Agrotechnologies and the Laboratory of Grape Storage of the FSBSI Institute Magarach of the RAS.

The objects of research are table varieties of ultra-early ripening ('Elegant Sverhrannij', 'Sverhrannij Bessemyannyj', 'Krymskaya Zhemchuzhyna', 'Arkadiya', 'Lora', 'Vostorg' (control)) and very early ripening varieties ('Galbena Nou', 'Kesha', 'Viva Ajka'). The type of research is a small-plot field experiment.

Culture is open-earth. The age of grape plantings of these varieties is from 8 to 10 years. Planting scheme is 3.0 x 1.5 m. Bush training is a two-armed cordon on a high trunk ('Kesha, 'Viva Ajka') and on a medium trunk ('Elegant Sverhrannij', Sverhrannij Bessemyannyj', Kishmish Luchistyj', 'Arkadiya', 'Lora', 'Vostorg', 'Galbena Nou'). Growth control system is a vertical trellis. Plots are watered with drip irrigation. The agrobiological, uvological and transportability characteristics of the studied varieties were studied.

The studies were carried out according to the methods generally accepted in viticulture: determining the fertility of eyes - by the method of microscopy (Method to determine qualitative heterogeneous fertility of central buds of grape eyes); phenology and agrobiology of the studied grape varieties; mechanical bunch]; determining the shipping quality of table grape varieties methodological recommendations for assessing the prospects of table grape varieties, 2014, developed by Boiko V.A. and Beibulatov M.R. [18]; assessment of quality and physicochemical indicators of grapes by [19]; mathematical data processing - in the SPSS Statistics 17.0 program. The soil covering is represented by cinnamonic brown soils [20].

3 Results and Discussion

3.1 Agro-biological, commercial quality and transportability criteria

Phenological observations showed the beginning of bud break in varieties of ultra-early and very early ripening to start in the Western Crimea 1-2 days earlier than in its Eastern part. But already in the stage of flowering, the onset of phenological growth stages becomes equal. The production period of varieties in different ripening groups varies insignificantly.

Modern grape varieties are characterized by higher values of agro-biological and commercial properties compared with varieties created two or three decades ago.

Table 1. Comparative characteristics of agro-biological indicators of table grape varieties

Grape variety	Coefficients				The power of shoot growth		The degree of shoot ripening		Yield		Output of standard products	
	fruiting		fertility		m	*	%	*	t/ha	*	%	*
	-	*	-	*								
'Elegant Sverhrannij'	0.74	4	1.34	3	2.98	4	90.3	5	16.1	4	80.1	2
'Sverhrannij Bessemyannyj'	0.54	3	1.20	2	2.36	3	89.3	4	10.2	2	78.6	1
'Kishmish Luchistyj'	0.89	5	1.32	3	3.5	5	93.4	5	18.1	5	71.8	1
'Arkadiya'	0.43	3	1.21	3	2.97	4	89.9	4	18.5	5	94.6	4
'Lora'	0.43	3	1.22	3	2.41	3	91.5	5	13.5	3	79.0	1
'Vostorg' (control)	0.85	5	1.25	3	2.36	3	84.5	4	18.7	5	84.2	2
'Galbena Nou'	0.65	4	1.2	2	2.66	4	91.2	5	17.8	4	84.6	2
'Kesha'	0.75	4	1.32	3	2.45	3	90.2	5	19.8	5	78.6	1
'Viva Ajka'	1.20	5	1.56	4	3.01	5	90.1	5	17.9	4	85.5	3

Note: * – grade

In 2014, in the Laboratory of Grape Agrotechnologies of the FSBSI Institute Magarach of the RAS, methodological recommendations for assessing the prospects of table grape varieties were developed by Beibulatov M.R., Boiko V.A. (2014) [18], since the formula to determine the transportability coefficient and quantity assessment of prospects, earlier developed by Dzheneev S.Yu. and Kolyanda N.K. (1975), is outdated now and not suitable for evaluating modern table grape varieties.

The example of assessing agro-biological indicators, as one of the components to evaluate the prospects of table grape varieties according to the improved methodological recommendations, is presented in Table 2.

Modern grape varieties are characterized by higher values of agro-biological and commercial quality, i.e. the force needed to separate a berry from the peduncle, the force to pierce and to crush a berry.

The developed complex assessment of table varieties includes: transportability indicators, taking into account the impact of such factors as the force to separate from the peduncle, to pierce or to crush a berry (Table 2); prospective quality assessment of table grape varieties, including a set of agro-biological, uvological and quality criteria, which is expressed in determining the index of potential prospects (IPP).

The transportability coefficient (Ct) of the studied varieties, calculated by the formula of Dzheneev S.Yu. and Kolyanda N.K. (1975) using different entries of ripening periods, is characterized by low values: for ultra-early ripening varieties – 17.4-48.5; for very early ripening varieties - 25.5-52.3 (Table 1). The transportability coefficient values of the studied varieties are at the control level, the varieties ‘Arkadiya’ and ‘Viva Ajka’ exceed this level, and the varieties ‘Elegant Sverhrannij’, ‘Sverhrannij Bessemyannyj’ and ‘Krymskaya Zhemchuzhyna’ are below the control level, while Ft=1.85< Ff, which indicates the significance of differences in terms of transportability indicators in the assessed grape varieties.

Summarizing the above calculations of transportability coefficient by the formula of Dzheneev S.Yu. and Kolyanda N.K. (1975), the obtained values of this indicator for new grape varieties were relatively low. Therefore, the method of Beibulatov M.R. and Boiko V.A. (2014) developed in in the Laboratory of Grape Agrotechnologies [18], was used to calculate the transportability coefficient (Ct *). According to this, shipping quality of table varieties was defined using the transportability coefficient, which takes into account the impact of every indirect indicator obtained using the equations (1-3):

$$T1=0.055*X1+0.134*X2+0,15*X3-113.2 \quad (1)$$
$$T2=0.0405*X1+0.1707*X2+0.1216*X3-93.2975 \quad (2)$$
$$T3=0.0248*X1+0.0937*X2+0.0915*X3-38.944 \quad (3),$$

where: T1 - low level of transportability,
T2 - average level of transportability,
T3 - high level of transportability.

According to the research results, the varieties under study can be classified as follows: ultra-early ripening varieties ‘Vostorg’, ‘Kesha’ and ‘Viva Ajka’ can be attributed to the high transportability group of varieties; the varieties ‘Arkadiya’ and ‘Lora’ – to the average transportability group of varieties; the varieties ‘Elegant Sverhrannij’, ‘Kishmish Luchistyj’, ‘Sverhrannij Bessemyannyj’ and ‘Galbena Nou’ - to the low transportability group of varieties.

Analyzing the obtained results of transportability coefficient by the formula of Dzheneev S.Yu. and Kolyanda N.K. (1975), as well as a complex prospective assessment of table grape varieties according to Beibulatov M.R. and Boiko V.A. (2014), it can be concluded that the

most suitable method for an objective estimation of grape transportability, is to assess the proportion of shipping properties of a variety by three transportability levels.

Table 2. Transportability indicators of table grape varieties

Grape variety	Force, g			Ct	Ct*
	to separate a berry from the peduncle (X1)	to pierce a berry (X2)	to crush a berry (X3)		
'Elegant Sverhrannij'	195	403	1130	26.6	57.1 (T3)
'Sverhrannij Bessemyannyj'	108	340	525	17.4	100 (T3)
'Kishmish Luchistyj'	193	371	935	24.5	90.0 (T3)
'Arkadiya'	565	565	1301	48.5	90.5 (T2)
'Lora'	339	403	1537	35.4	80.0 (T2)
'Vostorg' (control)	379	472	1286	37.6	56.0 (T1)
'Galbena Nou'	439	314	1142	35.0	60.0 (T3)
'Kesha'	460	318	1607	38.8	70.0 (T1)
'Viva Ajka'	578	553	1898	52.3	80.0 (T1)
HCP_{05}	58,28	62,76	73,37	-	-
Ft=1.85	Ff=43.35	Ff=12.00	Ff=102.97	-	-

Due to the increase in the weight of bunch and its volume in the studied varieties, the density of bunch was calculated according to new methodological recommendations by equation (4):

$$y=1.3492x+246.83, \quad (4)$$

where: x – bunch weight (g).

To calculate the bunch density coefficient of table grapes, following formula (5) was used:

$$K=(M/V)*k, \quad (5)$$

where: M – bunch weight (g),
V – bunch volume (cm^3),
k – correction factor (k=0.476).

Uvological and commodity indicators were also assessed using new methodology.

3.2 Potential perspectivity index

Based on a complex assessment and under the existing weather conditions of 2015-2020, all the studied table grape varieties in the conditions of Crimea (Fig. 1) were assessed as very promising ('Arkadiya' and 'Viva Ajka', IPP = 0.83), and promising ('Galbena Nou', IPP = 0.76; 'Elegant Sverhrannij' and 'Kesha', IPP = 0.73; 'Kishmish Luchistyj', IPP=0.72; 'Lora', IPP=0.71).

The variety 'Sverhrannij Bessemyannyj' is assessed at the level of control (IPP=0.68) as quite promising (IPP=0.64). The values of IPP in the distribution occur with identical probability. The standard deviation of IPP for all varieties by years of research ranges from 5.04 to 7.90.

Thus, such an approach and analysis make it possible to assess the prospects of new table varieties by the combination of indicators, different in their parameters from varieties bred 20-30 years ago.

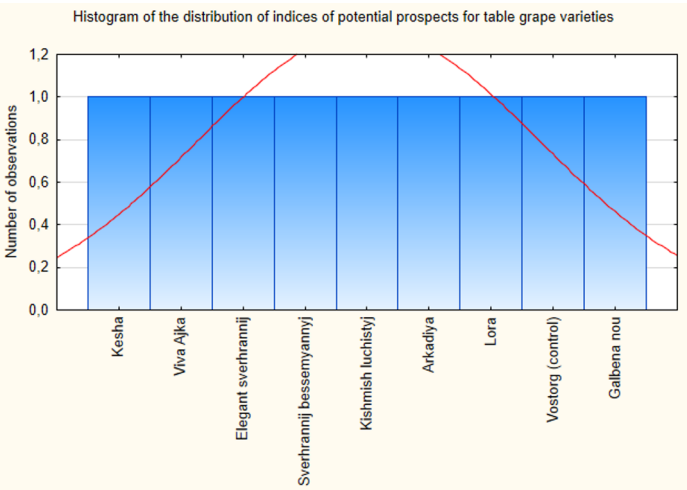

Fig. 1 Histogram of uniform distribution of IPP of the studied table grape varieties by years of research

4 Conclusion

In Western Crimea, the beginning of bud break in the studied varieties begins 1-2 days earlier than in the Eastern Crimea. Regardless of the cultivation zone, phenological growth stage of flowering begins evenly for all varieties of the same ripening period. The production period of varieties in different ripening groups varies insignificantly.

According to the degree of inflorescence initiation, three groups were distinguished: the varieties with a low shoot fertility (0.5-0.3) – 'Lora', 'Sverhrannij Bessemyannyj'; the varieties with an average shoot fertility (0.8-0.6) - 'Elegant Sverhrannij', 'Galbena Nou', 'Kesha', 'Vostorg' (control); the varieties with a high shoot fertility (1.1-0.9) – 'Kishmish Luchistyj', 'Arkadiya'; the varieties with a very high shoot fertility (1.2) – 'Viva Ajka'.

Table grape varieties under study have a strong and powerful bush growth vigor and perfect shoot ripening rate. It was established that shoot ripening in the varieties of all ripening periods proceeds better in the Eastern Crimea rather than in its Western part.

The highest cropping capacity in the group of ultra-early ripening varieties under study was registered for the cultivars growing in the Western Crimea: 'Arkadiya' and 'Vostorg' (18.5 t/ha and 18.7 t/ha) with a standard output of 84.2% and 94.6%, respectively. The varieties of very early ripening 'Kesha' and 'Galbena Nou' with cropping capacity of 19.8 t/ha and 17.8 t/ha, had an output of standard products 78.6% and 84.6%, respectively.

The mass concentration of sugars in grape berries of ultra-early ripening varieties of the Western Piedmont-Coastal region ranged from 135 to 194 g/dm3, the values of titratable acidity were from 4.0 to 6.5 g/dm3. The values of glucoacidimetric index for all varieties were above 25.

Table grape varieties which proved to be the best in tasting assessment are: 'Elegant Sverhrannij'- 8.1; 'Lora' - 8.5; 'Galbena Nou' - 8.7.

On the basis of approved methodology, shipping quality of the studied table grape varieties was assessed. High transportability coefficient (T1) was registered for 'Kesha', 'Viva Ajka' and 'Vostorg' (control) varieties.

The values of IPP were calculated basing on a complex assessment of the studied varieties: 'Arkadiya' and 'Viva Ajka' (IPP = 0.83) were assessed as very promising; 'Galbena Nou' (IPP=0.76), 'Elegant Sverhrannij' and 'Kesha' (IPP=0.73), 'Kishmish Luchistyj' (IPP=0.72), 'Lora' (IPP=0.71) - as promising. The variety 'Sverhrannij

Bessemyannyj' was estimated at the level of control (IPP=0.68) as quite promising (IPP=0.64).

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