Bulgarian Journal of Agricultural Science, 30 (No 6) 2024, 1004–1014

Comparative biometric characterisation of organs in the male flower sphere in seedless grapevine varieties (*Vitis vinifera* L.)

Venelin Roychev[1] and Neli Keranova[2*]

[1] *Agriculture University, Faculty of Horticulture with Viticulture, 4000 Plovdiv, Bulgaria*
[2] *Agriculture University, Faculty of Economics, 4000 Plovdiv, Bulgaria*
[*] *Corresponding author:* nelikeranova@abv.bg

Absrtact

Roychev, V. & Keranova, N. (2024). Comparative biometric characterisation of organs in the male flower sphere in seedless grapevine varieties (*Vitis vinifera* L.). *Bulg. J. Agric. Sci., 30*(6), 1004–1014

The influence of the location of flower buds in the inflorescence on the size variation of the male flower sphere organs – stamens, anthers and connective – was studied in 50 seedless grapevine varieties. They were found to be characterized by a large biometric diversity. In the case of vertically located flower buds on the inflorescence branches of the variants *base*, *middle* and *tip*, there is a high variability and statistically proven differences between different varieties. At the base of the inflorescence, they are distributed in eight generalized clusters, in the middle – in ten and towards the tip – in eight. The morphological differences found between the flower elements in the male sphere are mathematically plausible only in the individual variants, and they are not proven when comparing them as a whole. The sizes of stamens, anthers, and connective do not depend on the location of the flower buds in the inflorescence. Biometric data reflecting the parameters of these organs are representative for each variety, regardless of which part of the inflorescence the flower buds are located.

Keywords: male flower organs; comparative biometric characterization; seedless grapevine varieties

Introduction

The actual fertility and yield formation of grapevine varieties is determined by the complex morphogenesis and cytoembryological processes in their generative sphere. In seedless varieties, without the presence of pollination and fertilisation, normal grains in shape and size are not produced in the bunch. As a result of their different location on the inflorescence, the processes of micro- and megasporogenesis occur non-synchronously, which implies unequal levels of development of the male and female flower spheres – stamens – anther – pollen grains – seed buds – egg apparatus (Roytchev, 2008). Within the same plant, the size of pollen grains may depend on the position of the inflorescence on the plant or on the shoot, on the stamens in the flower, on the pollen grains in the anther, and on the flowering period (Sladkov, 1962). Sousa (1971) presented the results of a study of 33 grapevine varieties with undeveloped stamens in normal inflorescences. Agaoglu (1971) found that the timing of differentiation and development of flower parts in several grapevine varieties is different and not all flowers of an inflorescence go through the same developmental stages.

Chebukin (1997) studied 40 forms of the Amur grape and found considerable polymorphism, which is expressed in the amount of flowers in the inflorescences, the shape and size of the bunches, the seedbud, the pistil, the stigma, the height and shape of the nectaries, the length of the stamens and the nature of their arrangement. In some of the

known cytoimbriological and cytogenetic studies of various grapevine varieties, biometric data on individual elements of their flower characterization are found (Lepadatu, 1961, 1970; Litvak, 1966; Kozma & Scheuring, 1972; Yakimov et al., 1977; Kassemeyer & Staudt, 1981, 1982, 1983; Topale, 1983, 2011, etc.). The aim of this study was to determine the parameters of the organs in the male flower sphere in a large group of seedless grapevine varieties in relation to their location in the inflorescence and, by applying various mathematical methods, to establish the possibilities of using them as ampelographic characters.

Material and Methods

The experimental work included 50 seedless grapevine varieties grown in the Ampelographic Assortment of the Department of Viticulture at the Agricultural University of Plovdiv. For five consecutive years, 100 biometric measurements were performed with a biocular of the organs of the male flower sphere, including 5 indicators: length and width of the stalk of the stamen and anther and length of the connective. Flower buds were collected from the inflorescence at the beginning of the flowering phenophase. They were conventionally divided vertically into three variants: *base*, *middle* and *tip* along the length of the branches, bilaterally according to their proximity to the central axis of the inflorescence. *Hierarchical cluster analysis* was used to identify homogeneous groups of varieties. Dendrograms were built to graphically represent the stepwise grouping of individual varieties into clusters (groups). Statistical significance of the results was checked by one-way analysis of variance (ANOVA) and Duncan‘s multiple comparison test. Mathematical data processing was performed using the IBM Statistics SPSS 24 software product (Landau & Everitt, 2004; Morgan et al., 2020; Verma, 2020).

Results and Discussion

The seedless varieties studied are grouped according to the indicators of the male flower sphere at the *base* of the inflorescences when vertically arranged in eight clusters (Figure 1).

The first of these clusters includes varieties with proven similar stamen lengths, between 2.03 mm and 2.17 mm, and with smaller anther parameters, such as Nimrang x Sultanina, Corinth white, Russalka 3, Tarnow, Focha seedless, Vita, Italia x Sultanina, and Corinth black. The second is formed by varieties with similar stamen size, ranging from 1.90 mm in White seedless, to 2.25 mm – Kishmish irtishor. The third consists of Hybrid 23-4, Slavyanka, Seedless hybrid V-6, Kishmish Vira, Rushaky and Nishava. They are characterized by minimum length and very similar width of stamens and anthers. The fourth cluster includes the largest number of varieties – 17, which are similar in stamen size and relatively smaller anther width. Beauty seedless and Flame seedless have the smallest anther sizes and are referred to as the fifth separate cluster. The interspecific hybrid Vanessa seedless has statistically proven to have the largest anther width and connective length, and Kishmish luchistii has the longest stamen, which determines their separation into separate clusters.

According to the similarity of the studied indicators in the *middle* of the inflorescence branches, the seedless varieties are grouped into ten clusters, of which the first two are the largest (Figure 2).

One of them includes Nimrang x Sultanina, Corinth white, Focha seedless, Corinth black, Hybrid 23-4, Slavyanka, Corinth seedless, Condared 6, Russalka 3, Seedless Hybrid V-6, Kishmish irtishor, Kishmish black, Superior seedless and Trakyska perla, due to the statistically proven similarity in stamen stalk length and anther width. In the second cluster are Kishmish early, Vita, Askery, Italia x Sultanina, Kishmish luchistii, Red seedless, Perlette, Hybrid 21-17-71, Russalka 1, Kishmish tjurkmensky, Korsa kishmish, Early superior seedless, Kishmish vatkana, Kolarovets, Russalka, Ruby seedless, Tarnow, Kishmish moldavski, Kishmish hyshrau, White seedless, Sultana muscata and Hybrid 720-19. They are similar in the above indicators, but differ in larger values of the length of the stamen stalks. The third cluster includes Hybrid 36-16 and Kondarev 10, due to proven similarity in anther width, which have the largest values. Vanessa seedless again has performance parameters statistically proven to be different from those of the other varieties, as does Flame seedless, and form independent clusters. The sixth cluster includes Corinth rose, Dilight, Rosbul and Rushaky due to their proven similarity in stamen and anther sizes, which are some of the largest in size. With minimum stamen pedicel lengths and statically proven similarity are Kara Sultani and Sultanina gigas, Kishmish Vira and Nishava, which determines their inclusion in two separate clusters. Beauty seedless and Nedelchev VI-4 form two separate clusters due to the lack of similarity with the other varieties in the studied indicators.

According to the parameters of the studied indicators, in the zone of the tip of the inflorescence branches, the seedless varieties are divided into eight generalized clusters (Figure 3).

The first cluster is the largest and includes 26 varieties with shorter stamens and narrower anthers. The second consists of Kishmish irtishor, Corinth rose, Superior seedless

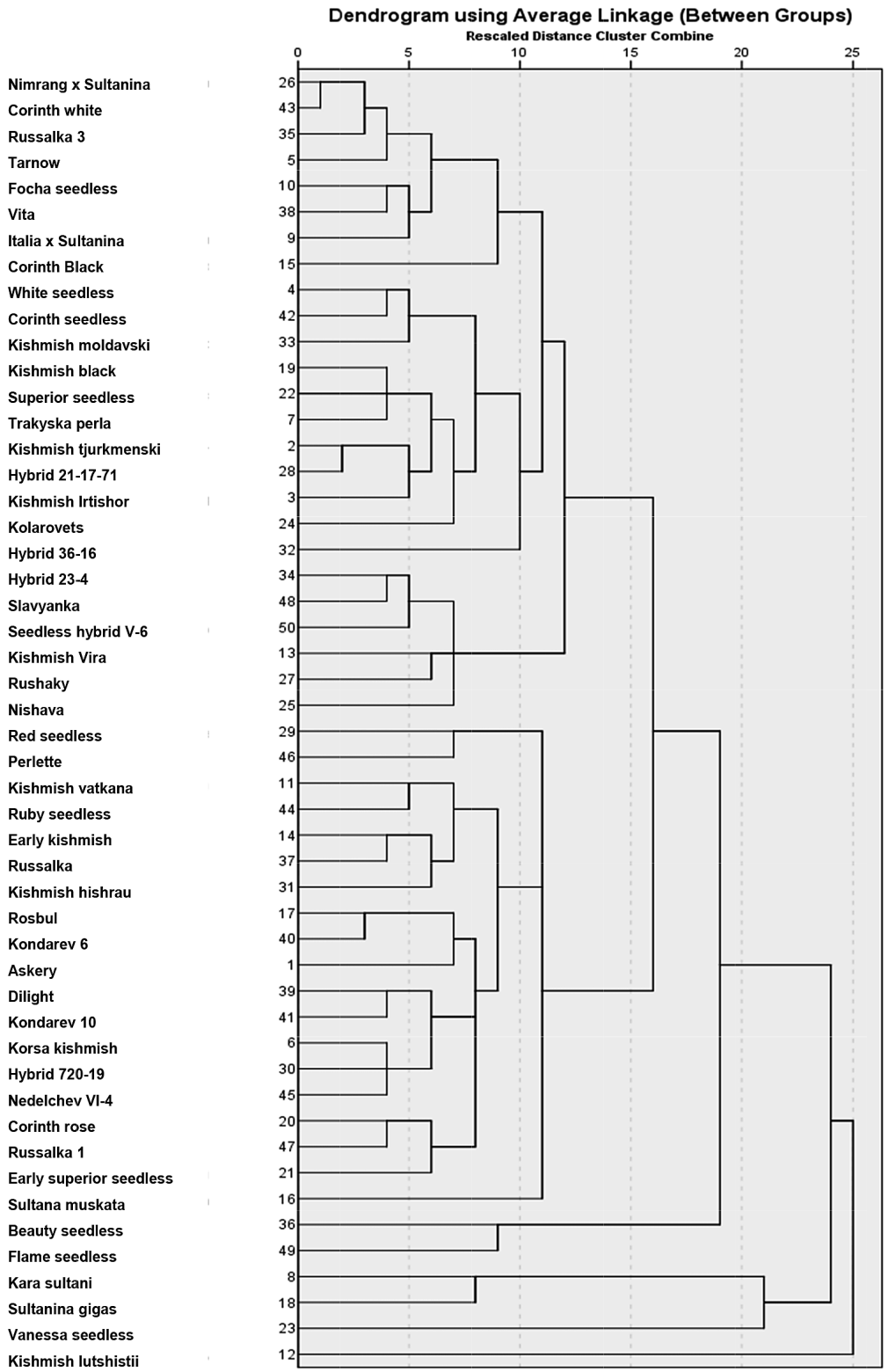

Fig. 1. Grouping of the studied seedless vine varieties according to the parameters of the organs in the male sphere of color with vertical separation of the branching of the fringe – base

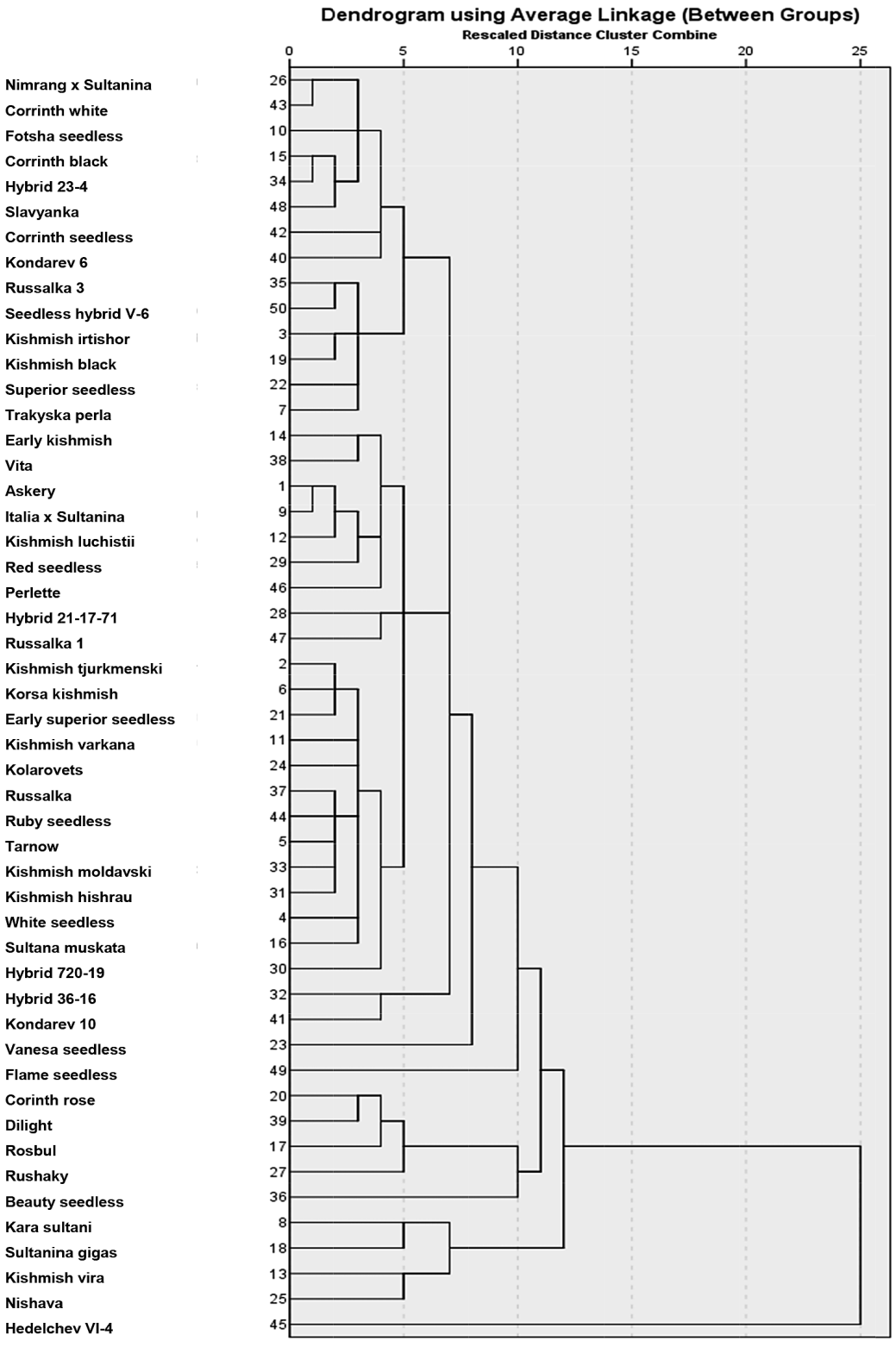

Fig. 2. Grouping of the studied seedless vine varieties according to the parameters of the organs in the male sphere of color with vertical separation of the branching of the fringe – middle

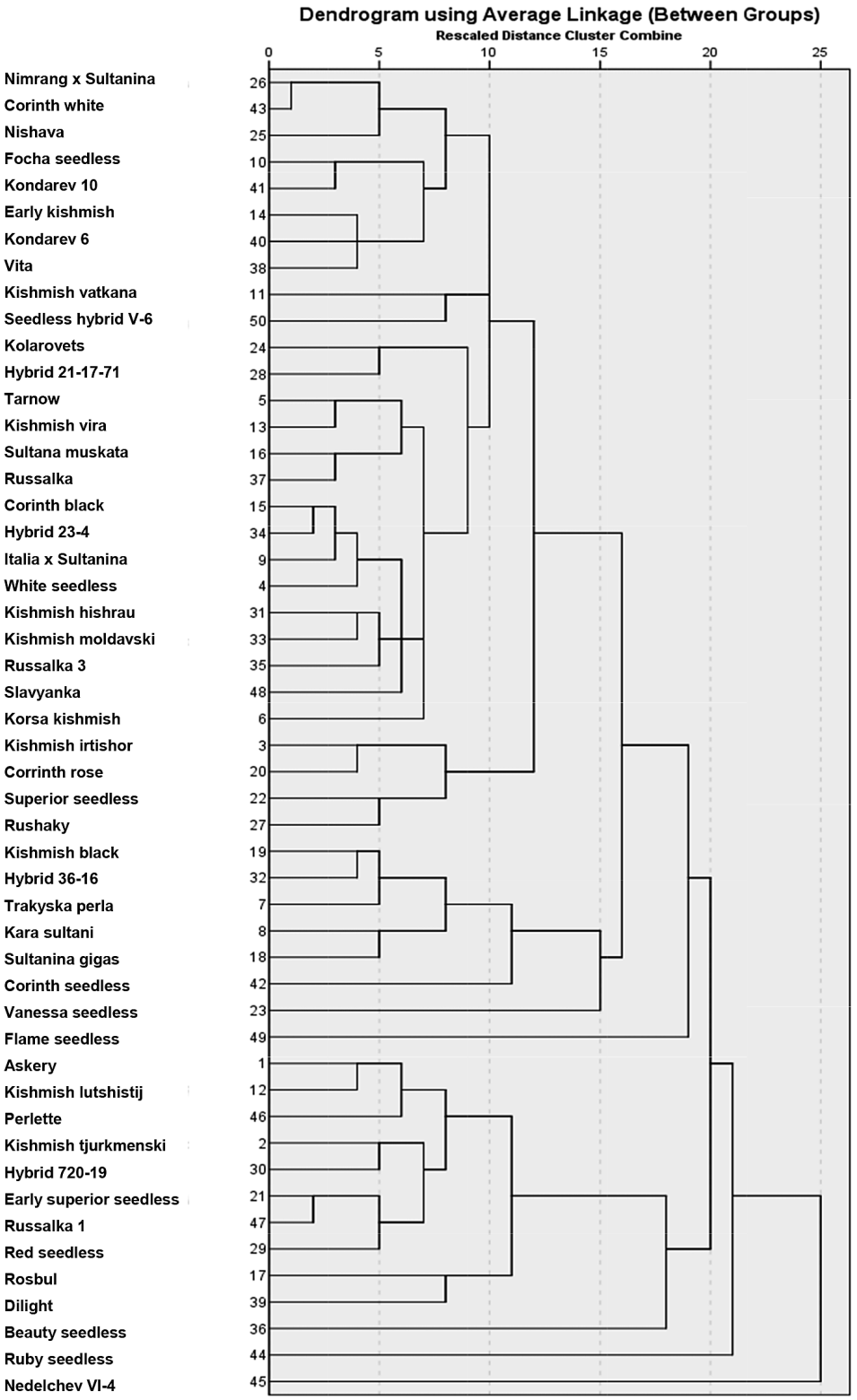

Fig. 3. Grouping of the studied seedless vine varieties according to the parameters of the organs in the male sphere of color with vertical separation of the branching of the fringe – tip

and Rushaky, characterized by shorter but wider stamen pedicels and larger anthers. The varieties with the shortest stamens form a third generalized cluster, ranging in length from 1.28 mm in Kara Sultani to 1.62 mm in Trakyska perla. Flame seedless is characterized by small stamen and anther sizes, which determines its separation into a separate cluster. In the following fifth cluster there are 10 varieties with similar stamen and anther width. Beauty seedless, Ruby seedless and Nedelchev VI-4 are divided into separate clusters, as they are distinguished by statistically proven differences in the parameters of the studied indicators and should not be grouped into common clusters.

The results of the comparative analysis of the studied indicators of the male flower sphere in the seedless varieties – *base* variant shows that the longest stamens are in Kishmish luchisty – 3.18 mm, the shortest in Kara sultani – 1.07 mm, and the greatest widths are in Early Superior seedless – 0.32 mm and Nimrang x Sultanina and Corinth white – 0.27 mm and the smallest – again in Sultanina gigas – 0.08 mm (Table 1). The longest anthers were recorded in Hybrid 36-16 at 1.42 mm and the shortest in Flame Seedless at 0.61 mm. The greatest width was recorded in Vanessa seedless – 1.28 mm, and Sultana muskata- 1.27 mm, while the least width was recorded in Flame seedless – 0.37 mm. Vanessa seedless has the longest connective -1.05 mm, and Beauty seedless the shortest – 0.13 mm.

There are also proven differences between the indicators of male flower sphere in the *middle* variant (Table 2). Rosbul has the longest stamen – 3.16 mm and Kara sultani has the shortest – 1.00 mm. The stamens are the widest at Trakyska perla – 0.41 mm, and the narrowest in Kara sultani – 0.08 mm. The length of the anthers is the largest in Hybrid 720-19 – 1.48 mm, and the smallest – in Flame seedless – 0.64. This indicator has the largest width at Kondarev 10 – 1.53 mm and the smallest – again at Flame seedless – 0.30 mm. The longest connective proved to be Vanessa seedless (0.94), and the shortest one – in Beauty seedless – 0.13 mm.

Table 1. Multidirectional comparative evaluation of seedless vine varieties according to the investigated indicators in the male sphere of color at vertical division of the branches of the fringe – base, mm

Cluster №	Seedless grapevine varieties	Stamens		Anthens		Connective
		Length	Width	Length	Width	Length
1	Nimrang x Sultanina	2.03 jklmno	0.27 a	1.02 nopqrst	0.88 hijklmnop	0.51 cdefgh
	Corinth white	2.03 jklmno	0.27 a	1.02 nopqrst	0.88 hijklmnop	0.51 cdefgh
	Russalka 3	2.12 ghijklm	0.21 abcd	0.99 opqrstu	0.94 efghijklmnop	0.50 defgh
	Tarnow	2.17 fghijklm	0.23 abcd	1.02 nopqrst	0.80 mnop	0.44 fghi
	Focha seedless	2.07 hijklmn	0.17 cdefg	0.97 qrstu	0.79 nop	0.29 klmn
	Vita	2.12 ghijklm	0.19 bcdef	0.84 u	0.82 lmnop	0.38 ijk
	Italia x Sultanina	2.07 hijklmn	0.13 fgh	0.98 pqrstu	0.96 defghijklmn	0.33 jkl
	Corinth Black	1.75 nopqrs	0.18 bcdefg	0.96 rstu	0.76 op	0.40 hij
2	White seedless	1.90 mnopqr	0.20 abcde	1.28 abcdefghi	0.98 cdefghijklm	0.57 cde
	Corinth seedless	1.99 klmnop	0.23 abcd	1.40 abc	1.07 bcdefg	0.58 bcd
	Kishmish moldavski	2.03 jklmno	0.21 abcd	1.23 cdefghijkl	1.04 bcdefgh	0.48 efghi
	Kishmish black	2.01 klmnop	0.19 bcdef	1.25 bcdefghijk	1.15 abc	0.28 lmno
	Superior seedless	2.05 ijklmn	0.19 bcdef	1.35 abcdef	1.10 bcde	0.33 jkl
	Trakyska perla	1.91 lmnopq	0.20 abcde	1.25 abcdefghij	1.03 bcdefghij	0.28 klmn
	Kishmish tjurkmenski	2.09 hijklmn	0.24 abc	1.33 abcdefg	0.97 cdefghijklmn	0.25 lmnop
	Hybrid 21-17-71	2.14 ghijklm	0.20 abcde	1.31 abcdefgh	1.01 cdefghijk	0.21 mnopq
	Kishmish Irtishor	2.25 efghijkl	0.18 bcdefg	1.19 fghijklmn	1.00 cdefghijkl	0.27 lmno
	Kolarovets	1.90 lmnopq	0.18 bcdefg	1.09 jklmnopqrst	1.10 bcde	0.21 mnopq
	Hybrid 36-16	1.75 nopqrs	0.25 ab	1.42 a	1.21 ab	0.27 lmno
3	Hybrid 23-4	1.70 opqrst	0.21 abcd	1.13 ijklmnopqr	0.98 cdefghijklm	0.43 ghi
	Slavyanka	1.68 pqrst	0.20 abcdef	1.20 defghijklm	0.95 efghijklmno	0.54 cdef
	Seedless hybrid V-6	1.55 st	0.22 abcd	1.07 klmnopqrst	1.06 bcdefgh	0.51 cdefgh
	Kishmish Vira	1.62 qrst	0.21 abcd	1.27 abcdefghi	0.94 efghijklmnop	0.67 b
	Rushaky	1.62 qrst	0.23 abcd	1.41 ab	1.04 bcdefghi	0.49 defgh
	Nishava	1.46 st	0.23 abcd	1.23 bcdefghijkl	0.85 ijklmnop	0.47 efghi

Table 1. Continued

4	Red seedless	2.70 bc	0.22 abcd	1.15 ghijklmnop	1.14 abcd	0.26 lmnop
	Perlette	2.83 b	0.29 ab	1.13 hijklmnopqr	0.90 ghijklmnop	0.19 nopq
	Kishmish vatkana	2.39 cdefghi	0.28 abc	1.16 ghijklmno	1.02 cdefghijk	0.43 ghi
	Ruby seedless	2.33 defghijk	0.23 abcd	1.20 efghijklm	0.97 cdefghijklmn	0.60 bc
	Early kishmish	2.37 cdefghij	0.19 bcdef	0.95 stu	0.85 jklmnop	0.33 jkl
	Russalka	2.36 cdefghij	0.20 abcdef	1.03 mnopqrst	0.84 klmnop	0.48 defghi
	Kishmish hishrau	2.55 bcde	0.22 abcd	1.07 lmnopqrst	0.90 ghijklmnop	0.47 efghi
	Rosbul	2.50 bcdef	0.13 efgh	1.17 ghijklmn	0.80 mnop	0.20 nopq
	Kondarev 6	2.46 cdefg	0.19 abcdef	1.11 ijklmnopqrs	0.84 klmnop	0.17 opq
	Askery	2.45 cdefg	0.22 abcd	1.23 bcdefghijkl	1.07 bcdefg	0.22 mnopq
	Dilight	2.39 cdefghi	0.21 abcd	1.35 abcdef	0.91 efghijklmnop	0.44 fghi
	Kondarev 10	2.41 cdefgh	0.20 abcde	1.38 abcd	0.91 fghijklmnop	0.31 jklm
	Korsa kishmish	2.54 bcde	0.24 abc	1.40 abc	0.95 defghijklmn	0.44 fghi
	Hybrid 720-19	2.66 bcd	0.19 bcdef	1.37 abcde	0.89 ghijklmnop	0.48 defghi
	Nedelchev VI-4	2.55 bcde	0.24 ab	1.25 abcdefghij	0.92 efghijklmnop	0.41 ghij
	Corinth rose	2.60 bcde	0.24 abc	1.25 bcdefghijk	1.09 bcdef	0.27 lmno
	Russalka 1	2.45 cdefg	0.22 abcd	1.23 bcdefghijkl	1.07 bcdefg	0.22 mnopq
	Early superior seedless	2.61 bcd	0.32 a	1.12 ijklmnopqrs	0.96 defghijklmn	0.23 lmnopq
	Sultana muskata	2.36 cdefghij	0.17 cdefg	1.15 hijklmnopq	1.27 a	0.51 cdefg
5	Beauty seedless	2.36 cdefghij	0.21 abcd	0.83 u	0.60 q	0.13 q
	Flame seedless	2.14 ghijklm	0.16 defg	0.61 v	0.37 r	0.16 pq
6	Kara sultani	1.07 u	0.12 gh	1.05 mnopqrst	0.95 efghijklmno	0.21 mnopq
	Sultanina gigas	1.37 t	0.08 h	0.93 tu	0.98 cdefghijklm	0.31 jklm
7	Vanessa seedless	1.57 rst	0.20 abcdef	1.06 lmnopqrst	1.28 a	1.05 a
8	Kishmish lutshistii	3.18 a	0.19 bcdef	1.01 nopqrst	0.75 p	0.33 jkl

a.b.c.… – Sign. level α = 0.05

Table 2. Multidirectional comparative evaluation of seedless vine varieties according to the investigated indicators in the male sphere of color at vertical division of the branches of the fringe – middle, mm

Cluster №	Seedless grapevine varieties	Stamens		Anthens		Connective
		Length	Width	Length	Length	Width
1	Nimrang x Sultanina	1.90 hijk	0.24 bcd	1.00 nopqr	0.66 fgh	0.48 bcdef
	Corrinth white	1.90 hijk	0.24 bcd	1.00 nopqr	0.66 fgh	0.48 bcdef
	Fotsha seedless	1.97 ghijk	0.16 efghi	1.06 klmno	0.64 gh	0.32 hijk
	Corrinth black	1.9 hijk	0.18 bcdefghi	0.98 opqr	0.86 cdefg	0.40 fgh
	Hybrid 23-4	1.9 hijk	0.19 bcdefghi	0.98 opqr	0.95 cdefg	0.40 fgh
	Slavyanka	1.88 hijk	0.16 efghi	1.05 klmno	0.86 cdefg	0.49 bcdef
	Corrinth seedless	1.67 kl	0.16 efghi	0.98 opqr	0.78 defgh	0.56 bc
	Kondarev 6	1.76 jk	0.15 fghi	0.91 qrs	0.77 defgh	0.19 mnop
	Russalka 3	1.95 ghijk	0.21 bcdefg	1.24 cdefgh	0.95 cdefg	0.51 bcd
	Seedless hybrid V-6	1.82 ijk	0.19 bcdefghi	1.30 bcd	1.06 bcdef	0.49 bcdef
	Kishmish irtishor	1.99 ghijk	0.20 bcdefgh	1.19 defghij	1.01 bcdefg	0.24 jklmno
	Kishmish black	1.83 ijk	0.21 bcdefg	1.24 cdefgh	1.06 bcdef	0.31 hijkl
	Superior seedless	1.88 hijk	0.26 b	1.39 ab	1.15 bcd	0.26 ijklmn
	Trakyska perla	1.92 hijk	0.41 a	1.30 bcd	0.96 cdefg	0.35 ghi

Table 2. Continued

2	Early kishmish	2.36 defg	0.19 bcdefghi	0.90 rq	0.82 cdefg	0.27 ijklm
	Vita	2.52 def	0.18 cdefghi	0.83 s	0.78 cdefgh	0.16 nop
	Askery	2.55 de	0.25 bc	1.24 cdefg	1.19 abc	0.24 klmno
	Italia x Sultanina	2.52 def	0.15 fghi	1.03 lmnop	0.91 cdefg	0.34 ghij
	Kishmish luchistii	2.53 def	0.18 bcdefghi	1.13 hijklm	0.88 cdefg	0.26 ijklmn
	Red seedless	2.52 def	0.18 bcdefghi	1.25 cdefg	0.80 cdefgh	0.19 mnop
	Perlette	2.73 cd	0.24 bcd	1.00 nopqr	0.83 cdefg	0.15 op
	Hybrid 21-17-71	2.22 efghi	0.18 bcdefghi	1.25 cdefgh	1.19 abc	0.21 lmnop
	Russalka 1	2.55 de	0.25 bc	1.243 cdefgh	1.19 abc	0.24 klmno
	Kishmish tjurkmenski	2.14 efghij	0.22 bcdef	1.26 bcde	0.94 cdefg	0.32 ghijk
	Korsa kishmish	2.17 efghij	0.17 defghi	1.34 bc	0.94 cdefg	0.40 efgh
	Early superior seedless	2.21 efgh	0.22 bcdef	1.30 bcd	0.91 cdefg	0.28 ijklm
	Kishmish varkana	2.23 efghi	0.12 ij	1.08 jklmno	0.98 bcdefg	0.34 ghij
	Kolarovets	2.21 efghi	0.22 bcdef	1.16 efghijk	0.96 cdefg	0.19 mnop
	Russalka	2.30 efgh	0.20 bcdefg	1.13 ghijklm	0.80 cdefgh	0.46 cdef
	Ruby seedless	2.39 defg	0.19 bcdefghi	1.15 fghijk	0.85 cdefg	0.51 bcde
	Tarnow	2.29 efgh	0.21 bcdefg	1.11 ijklmn	0.97 cdefg	0.35 ghi
	Kishmish moldavski	2.29 efgh	0.24 bcd	1.14 fghijkl	0.91 cdefg	0.42 defg
	Kishmish hishrau	2.37 defg	0.22 bcdef	1.04 klmno	0.93 cdefg	0.45 def
	White seedless	2.16 efghij	0.25 bc	1.26 bcde	0.86 cdefg	0.57 b
	Sultana muskata	2.11 fghij	0.17 defghi	1.09 jklmno	0.80 cdefgh	0.47 bcdef
	Hybrid 720-19	2.27 efgh	0.0 bcdefg	1.48 a	0.98 bcdefg	0.45 def
3	Hybrid 36-16	1.88 hijk	0.26 b	1.19 defghij	1.35 ab	0.28 ijklm
	Kondarev 10	2.15 efghi	0.16 efghi	1.11 jklmn	1.53 a	0.23 klmno
4	Vanesa seedless	1.87 hijk	0.23 bcde	0.99 opqrs	0.80 cdefgh	0.94 a
5	Flame seedless	2.21 efghi	0.22 bcdef	0.64 t	0.30 i	0.15 op
6	Corinth rose	3.12 ab	0.26 b	1.24 cdefgh	1.13 bcde	0.40 fgh
	Dilight	3.09 abc	0.22 bcdef	1.32 bc	0.93 cdefg	0.47 bcdef
	Rosbul	3.16 a	0.17 defghi	1.23 cdefghi	0.79 cdefgh	0.25 ijklmno
	Rushaky	2.77 bcd	0.22 bcdef	1.28 bcd	1.06 bcdef	0.48 bcdef
7	Beauty seedless	3.14 ab	0.13 ghij	0.66 t	0.43 hi	0.13 p
8	Kara sultani	1.00 n	0.08 j	1.02 mnopq	0.99 bcdefg	0.22 klmnop
	Sultanina gigas	1.38 lm	0.12 hij	0.93 pqrs	0.91 cdefg	0.21 lmnop
9	Kishmish vira	1.27 mn	0.16 efghi	1.23 cdefghi	0.94 cdefg	0.90 a
	Nishava	1.24 mn	0.23 bcde	1.27 bcd	0.74 efgh	0.48 bcdef
10	Hedelchev VI-4	2.03 ghijk	0.18 bcdefghi	1.24 cdefgh	0.84 cdefg	0.54 bcd

a.b.c.… – Sign. level $\alpha = 0.05$

The comparative assessment also proved the existence of differences between the indicators for the *tip* variant (Table 3). The stamens are the longest in Rosbul – 3.14 mm, and shortest in Kara sultani – 1.28 mm. They are the widest in Kishmish moldovski – 0.30 mm, and narrowest in Kara sultani – 0.08 mm. The anthers have a maximum length in Superior seedless – 1.39 mm and Rushaky – 1.38 mm, and minimum length in Beauty Seedless – 0.67 mm. They are the widest in Kishmish Irtishor – 1.37 mm and the smallest in Flame seedless – 0.23 mm. The connective is the longest in Ruby seedless – 1.13 mm and the shortest in Perlette and Kolarovets – 0.12 mm.

There were no proven differences in the comparative analysis between the performance data of all treatments – *base* : *middle* : *tip*, implying that the vertical location of the flower buds along the inflorescence branches have no effect on stamen, anther and connective sizes (Table 4).

Table 3. Multidirectional comparative evaluation of seedless vine varieties according to the investigated indicators in the male sphere of color at vertical division of the branches of the fringe – tip, mm

Cluster №	Seedless grapevine varieties	Stamens		Anthens		Connective
		Length	Width	Length		Length
1	Nimrang x Sultanina	1.84 mnopqrs	0.19 cdefghi	0.84 qrstu	0.66 m	0.43 cdef
	Corinth white	1.84 mnopqrs	0.19 cdefghi	0.84 qrstu	0.66 m	0.43 cdef
	Nishava	1.78 opqrstu	0.22 abcdefgh	0.98 lmnopq	0.77 klm	0.48 cd
	Focha seedless	1.80 nopqrst	0.19 cdefghi	1.08 hijklmno	0.80 hijklm	0.26 cdef
	Kondarev 10	1.89 lmnopqr	0.18 defghij	1.02 jklmno	0.79 hijklm	0.19 def
	Early kishmish	2.06 lmnop	0.15 ghijkl	0.81 stu	0.78 ijklm	0.26 cdef
	Kondarev 6	1.95 klmnopq	0.10 jkl	0.85 pqrst	0.85 fghijkl	0.25 cdef
	Vita	2.03 lmnop	0.17 defghij	0.82 rstu	0.92 efghijk	0.15 ef
	Kishmish vatkana	1.70 pqrstu	0.21 cdefgh	1.10 ghijklmn	0.94 efghijk	0.49 cd
	Seedless hybrid V-6	1.78 opqrstu	0.23 abcdefgh	1.25 abcdefg	0.66 m	0.41 cdef
	Kolarovets	2.33 efghij	0.19 cdefghi	1.14 defghijk	0.93 efghijk	0.12 f
	Hybrid 21-17-71	2.24 ghijkl	0.18 defghij	1.26 abcdeg	1.03 cdef	0.19 def
	Tarnow	2.35 defghij	0.29 abc	1.12 fghijkl	0.86 efghijkl	0.49 cd
	Kishmish vira	2.34 defghij	0.25 abcd	1.06 hijklmno	0.78 jklm	0.48 cd
	Sultana muskata	2.16 klmn	0.17 defghij	1.07 hijklmno	0.71 lm	0.42 cdef
	Russalka	2.18 jklm	0.15 hijkl	1.15 cdefghij	0.78 jklm	0.43 cdef
	Corinth black	2.03 lmnop	0.2 cdefgh	1.01 jklmno	0.9 efghijk	0.40 cdef
	Hybrid 23-4	2.05 lmnop	0.21 cdefgh	0.97 lmnopq	0.97 defgh	0.41 cdef
	Italia x Sultanina	1.99 lmnop	0.11 ijkl	0.99 klmnop	0.96 defghij	0.36 cdef
	White seedless	1.99 lmnop	0.22 abcdefgh	1.02 jklmno	0.92 efghijk	0.55 c
	Kishmish hishrau	2.22 ghijkl	0.23 abcdefg	1.09 hijklmno	0.92 efghijk	0.50 cd
	Kishmish moldavski	2.17 klmn	0.30 a	1.20 cdefghi	0.90 efghijk	0.41 cdef
	Russalka 3	2.08 klmno	0.23 abcdefgh	1.16 cdefghij	1.04 bde	0.50 cd
	Slavyanka	2.05 lmnop	0.2 cdefgh	1.12 efghijk	1.01 cdefg	0.23 cdef
	Korsa kishmish	2.04 lmnop	0.16 fghijk	1.30 abc	0.83 ghijkl	0.35 cdef
2	Kishmish irtishor	2.05 jklmnop	0.23 abcdefg	1.26 abcdeg	1.37 a	0.35 cdef
	Corrinth rose	2.11 klmno	0.20 cdefgh	1.00 abcdeg	1.25 ab	0.24 cdef
	Superior seedless	2.01 lmnop	0.23 abcdefg	1.39 a	1.04 bde	0.38 cdef
	Rushaky	1.93 klmnopqr	0.27 abc	1.38 a	1.16 bc	0.50 cd
3	Kishmish black	1.43 uv	0.23 abcdef	1.11 fghijklmn	1.12 bcd	0.27 cdef
	Hybrid 36-16	1.45 tuv	0.21 cdefgh	1.16 cdefghij	0.94 defghijk	0.26 cdef
	Trakyska perla	1.62 qrtsu	0.23 abcdefg	1.20 cdefghi	1.04 bde	0.26 cdef
	Kara sultani	1.28 v	0.08 l	1.05 ijklmno	0.90 efghijk	0.26 cdef
	Sultanina gigas	1.46 tuv	0.09 kl	0.94 opqrs	0.90 efghijk	0.25 cdef
	Corinth seedless	1.51 stuv	0.23 abcdefg	0.79 tuv	0.63 m	0.21 def
	Vanessa seedless	1.59 rstuv	0.23 abcdefgh	0.96 nopqr	0.92 efghijk	0.86 b
4	Flame seedless	2.11 klmno	0.21 bcdefgh	0.71 uv	0.23 o	0.20 def

Table 3. Continued

5	Askery	2.70 bcd	0.19 cdefghi	1.27 abcde	0.96 defghi	0.24 cdef
	Kishmish lutshistij	2.62 cdef	0.18 defghi	1.00 klmnop	0.77 klm	0.33 cdef
	Perlette	2.67 bcde	0.23 abcdefgh	0.96 mnopqr	0.78 ijklm	0.12 f
	Kishmish tjurkmenski	2.05 lmnop	0.22 abcdefgh	1.29 abcd	1.04 bde	0.34 cdef
	Hybrid 720-19	2.62 cdef	0.20cdefgh	1.25 abcdefg	0.99 defg	0.41 cdef
	Early superior seedless	2.68 bcde	0.23 abcdefgh	1.21 bcdefgh	0.95 defghijk	0.21 def
	Russalka 1	2.70 bcd	0.19 cdefghi	1.27 abcde	0.96 defghi	0.24 cdef
	Red seedless	2.53 defgh	0.21 bcdefgh	1.21 bcdefgh	0.80 hijklm	0.19 def
	Rosbul	3.14 a	0.16 cdefghij	1.07 hijklmno	0.93 efghijk	0.28 cdef
	Dilight	2.92 abc	0.22 abcdefgh	1.28 abcd	0.91 efghijk	0.47 cde
6	Beauty seedless	2.99 ab	0.24 abcde	0.67 v	0.47 n	0.13 f
7	Ruby seedless	2.29 fghijk	0.19 cdefghi	1.25 abcdefg	0.85 efghijkl	1.13 a
8	Nedelchev VI-4	2.55 defg	0.20 0cdefgh	1.36 ab	0.89 efghijkl	0.52 bc

a.b.c.… – Sign. level α = 0.05

Table 4. Multidirectional comparative evaluation of seedless vine varieties according to the investigated indicators in the male sphere of color at vertical division of the branches of the fringe

Variants	Stamens		Anthens		Connective
	Length	Width	Length	Length	Width
Base	2.15	0.20	1.14	0.94	0.38
Middle	2.13	0.22	1.11	0.92	0.37
Tip	2.10	0.21	1.09	0.88	0.36
Sign. (0.05)	0.851	0.827	0.263	0.254	0.768

Conclusions

The organs of the male flower sphere – stamens, anthers and connective, in the studied seedless grapevine varieties, are characterized by great biometric diversity. In each group of indicators, in the vertically located on the branches of the rachis flower buds of the *base*, *middle* and *tip* variants, there is a high variability and statistically proven differences between individual varieties, since the ranks of their letter classification vary widely. At the *base* of the inflorescence they are distributed into eight generalised clusters, in the *middle* into ten and towards the *tip* into eight, with a different number of varieties in each cluster.

The morphological differences found between the flower elements in the male sphere are mathematically reliable only for individual variants, and when comparing them as a whole, they are not proven. The location of the flower buds in the inflorescences does not affect the sizes of stamens, anthers and connectives. The biometric data reflecting the parameters of these organs are representative for each variety, regardless of which part of the inflorescence the flower buds are located.

Acknowledgements

The authors thank for the financial support of the Agricultural University of Plovdiv.

References

Agaoglu, Y. S. (1971). A study on the differentiation and the development of floral parts in grapes (*Vitis vinifera* L. var). *Vitis*, *10*, 20-26.

Chebukin, P. A. (1997). Intraspecific diversity of Amur grapes based on the morphological characteristics of the flower. *Grapes and Wine of Russia, 1*, 21-24 (Ru).

Kassemeyer, H. H. & Staudt, G. (1981). On the development of the embryo sac and the fertilization of the vines. *Vitis, 20*, 209-210.

Kassemeyer, H. H. & Staudt, G. (1982). Cytological investigations into the causes of shriveling of *Vitis vinifera. Vitis, 21,* 121-135.

Kassemeyer, H. H. & Staudt, G. (1983). On the growth of endo-

sperm, embryo and ovules of *Vitis vinifera*. *Vitis, 22*, 109-119 (German).

Kozma, P. & Scheuring, J. (1972). Muscovy, the queen of solo gardens, flower teratomas of the afuz ali and cardinal solo varieties. Pendant print from the University of Horticulture's Kozelemeny. *Sept. Publ. Horticulture Univ., XXXVI*, 15-37.

Landau, S. & Everitt, B. (2004). A handbook of statistical analyses using SPSS. *Charman & Hall/CRC Press,* London, UK, 141.

Lepadatu, V. (1961). Studio proceeds to the fertilization of life according to the differences of polarization. The stay of Lucrari. Inst. cercetari hortivites.1959-1960. Bucuresti, 585-602 (Fr).

Lepadatu, V. (1970). An aspect of microsporogenesis and macrosporogenesis of life. *An. Inst. Vitis vinifera, 2*, 65-81 (Fr).

Litvak, A. I. (1966). On the development of the male gametophyte of some angiosperms according to microfilm photography and luminescent microscopy. Author's abstract. dis., Saratov, 21 (Ru).

Morgan, G., Barrett, K., Leech, N. & Gloeckner, G. (2020). IBM SPSS for introductory statistics: use and interpretation. Routledge, New York, USA, 54.

Roychev, V. (2008). Cytoembryological, biotechnological, ampelographic and selection-genetic studies on a seedless variety of vine (*Vitis vinifera* L.). Dissertation, Plovdiv, Part I – 491, Part II – 372 (Bg).

Sladkov, A. N. (1962). Morphology of pollen and spores of modern plants in the USSR in connection with the methods of its practical application. Ed. Moscow University, 255 (Ru).

Sousa, C. L. O. M. (1971). Unproductivity of video cultivars with retroreflective prints. *Agron. Lusitana, 32*(1-4), 127-183.

Topale, Sh. G. (1983). Polyploidy in grapes. Systematics, Karyology, Cytogenetics. *Chisinau,* "Shtiintsa", 215 (Ru).

Topale, S. G. (2011). Karyology, polyploidy and distant hybridization of grapes (systematics and cytogenetics of grapes). 2nd edition, corrected and expanded. *Chisinau,* 560 (Ru).

Verma, J. P. (2020). Data analysis in management with SPSS Software. *Springer,* New Delhi, 222.

Yakimov, L. M., Ludnikova, L. A., Yu Balan, G. & Maltabar, T. V. (1977). Atlas of Grape Embryology. *Chisinau,* 163 (Ru).

Received: October, 19, 2023; ***Approved***: January, 17, 2024; ***Published:*** December, 2024