Bulgarian Journal of Agricultural Science, 24 (No 5) 2018, 807–814

Comparative palynobiometric study of seedless vine cultivars and hybrid forms (*Vitis vinifera* L.)

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Abstract

Roychev, V. (2018). Comparative palynobiometric study of seedless vine cultivars and hybrid forms (*Vitis vinifera* L.). *Bulgarian Journal of Agricultural Science*, *24*(5), 807–814

A palynobiometric study of seedless vine cultivars and hybrid forms has been carried out. It has been established that statistically proven differences exist in the dimensions of the most important elements of the pollen aperture complex in the researched seedless cultivars and hybrid vine forms. The statistical groups formed according to the individual indicators are specific for each cultivar and fully reflect the observed palynobiometric polymorphism. The variability of polar axis length is influenced by all studied indicators of the ultrasculptural ornamentation of the pollen exine in the two conditional groups of cultivars. It depends to the greatest extent on the variation of the parameters of the equatorial axis and colp length.

Keywords: seedless vine cultivars; pollen; palynobiometric characteristics; multifactorial dispersion analysis; factor analysis

Introduction

The application of contemporary statistical methods to study the micro-morphological characteristics of pollen grains in different vine cultivars expands their ampelographic description and the possibilities for identification and classification. Pallinological scanning electron microscope observations have been carried out on seeded and seedless vine cultivars by a number of authors (Reille, 1966; Kasirszkaja and Kozma, 1981; Kasirszkaja, 1982, 1984; Lombardo et al., 1978; Alvares et al., 1998; Inceoglu et al., 2000). The results obtained are used in ampelographic systematics and the cultivar identity scheme (Korkutal et al., 2004; Marasali et al., 2005; Gallardo et al., 2009; Baby et al., 2015; Radović et al., 2016). The possibilities of using the shape and size of the elements of the pollen aperture complex are of interest in the context of the microstructural analysis for the purposes of correct grouping and identification of genotypes, as well as for determining their relative weight in the taxonomic process. The objective of this study is to establish the presence or absence of a relation between the surface relief specifics of pollen grains and their dimensions in seedless vine cultivars and hybrid forms.

Materials and Methods

The experimental work involves results from the scanning electron microscope biometric measurements of aperture elements of the pollen exine complex in 70 seedless cultivars and hybrid vine forms – polar axis, equatorial axis, mesocolpium, apocolpium, length, width, and depth of the colp, length and width of the pore in μm (Terziisky and Karageorgiev, 1989). The studied cultivars are conditionally divided into two groups: the first – including predominantly newly developed seedless cultivars and hybrid forms, and the second – known old seedless cultivars. The data on each individual pollen indicator by cultivar groups are processed by means of a comparative multifactorial dispersion analysis (Mokreva, 2007). For a complex investigation into their influence on the most generalizing of them – the polar axis, accepted as a dependent variable, for a part of the cultivars, representatives of the formed statistical groups of proof, factor analysis is applied, where the determination coefficient R^2 in the analysis is interpreted after its transformation into percentages (R^2.100) (Bryant and Yarnold, 1995; Iliev et al., 2008a, b; Gocheva-Ilieva and Iliev, 2009). The biometric data for the studied indicators are collected for ten consecutive years, with individual apertures of each cultivar being measured on at least 30 pollen grains in different exposures. SPSS statistical tool functioning in the Windows operating system environment is used for the interpretation of the obtained results.

Results and Discussion

The multifactorial comparative analysis of the most important elements of the pollen aperture complex in the studied newly developed seedless cultivars and hybrid forms from the first group shows that there are proven differences in their sizes (Table 1). The variation in the absolute values of the polar axis length is from 19.03 µm (Russalka 3A) to 29.77 µm (Russalka 2). In this interval, eight groups of cultivars are formed, with proven differences between them – ***a, b, c, d, e, f, g, h*** and, therefore, they can be differentiated steadily according to this indicator. The equatorial axis varies from 11.82 µm (Emerald Seedless) to 18.22 µm (Hybrid V-6). The diversity of the formed groups of cultivars with proven differences in this indicator is greater – from ***a*** to ***l***. According to the size of the mesocolpium, cultivars are also distributed into a large number of groups – from ***a*** to ***f***, and their values are within the range from 8.94 µm (Russalka) to 14.20 µm (Thracian Pearl). Although the variations in the size of the apocolpium in the separate cultivars are small – from 4.07 µm (Emerald Seedless) to 6.46 µm (Kishmish Moldavskii), the number of differentiated groups is comparatively large – from ***a*** to ***i***. The length of pollen colp varies within the range from 16.98 µm (Russalka) to 26.10 µm (Russalka 2) and the cultivars with statistically proven differences in this indicator form groups from ***a*** to ***i***. In colp width, the range of variation is significantly narrower – from 0.67 µm (Russalka 1) – ***e***, to 1.59 µm (Russalka) – ***a***. Due to the objectively more difficult measurement of the depth of pollen colp, despite the small differences between the cultivars, they are arranged in more groups – from ***a*** to ***j***. It should be noted that only a few cultivars are allocated in the first three of them with the largest values of the indicator – ***a***, ***b***, ***c***: Russalka – 0.937 µm, Tarnau – 0.830 µm, Kolarovets – 0.802 µm, Russalka 5 A – 0.807 µm and Corinth Seedless – 0.757 µm. The length of the pore in some of the cultivars is smaller than its width. The formed groups of proof be-

Table 1

Multifactorial comparative analysis of the sizes of the most important elements of pollen aperture complex in the studied seedless vine cultivars and hybrid forms (µm)

First Group Cultivars	Polar axis		Equatorial axis		Mesocolpium		Apocolpium		Colp length		Colp width		Colp depth		Pore length		Pore width
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Russalka 2	29,77	a	17,07	ab	12,23	c	4,26	i	26,10	a	0,98	ab	0,623	ef	3,342	a	1,530c
Thompson Seedless	28,71	a	15,77	d	12,81	c	5,10	cd	24,44	b	0,79	d	0,477	ij	0,542	j	1,558c
Apirena di Valetri	27,23	b	15,58	e	12,56	c	4,96	de	25,14	ab	0,95	b	0,497	ij	0,928	hi	0,837k
Hybrid 5-2	27,23	b	14,67	h	13,51	ab	5,31	bc	23,40	c	0,73	d	0,498	ij	1,898	fg	1,390e
Aperena Bruni	27,22	b	15,18	g	11,37	d	4,88	ef	23,28	c	1,13	ab	0,587	gh	2,280	e	1,357f
Hybrid V-6	27,03	b	18,22	a	13,06	b	4,46	i	24,13	b	1,09	ab	0,685	de	1,632	g	1,505d
Hybrid 1-52	26,85	b	16,83	c	12,11	c	4,96	de	24,20	b	0,79	d	0,520	ij	2,688	c	1,643c
Rusensko Seedless	26,53	b	15,53	e	11,65	cd	5,70	ab	22,19	d	0,95	b	0,535	ij	2,338	de	1,772b
Kondarev 6	26,44	b	16,46	c	12,06	c	5,81	ab	21,08	e	0,83	c	0,602	fg	2,650	c	2,287a
Kishmish Moldavskii	26,16	b	15,40	f	13,65	ab	6,46	a	24,04	b	0,93	b	0,548	ij	0,977	hi	1,577c
Hybrid 20-4	26,10	b	13,84	j	11,38	d	5,97	ab	21,81	e	0,73	d	0,498	ij	2,032	fg	1,237h
Vita	25,69	c	15,54	e	11,42	d	5,41	bc	22,49	d	0,87	c	0,605	ef	0,600	j	1,435e
Early Seedless	25,55	c	14,85	h	11,39	d	5,03	cd	21,11	e	0,75	d	0,458	ij	0,922	hi	0,805k

Table 1 (Continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Perlette	25,53	c	14,51	i	11,16	d	5,58	bc	20,24	f	0,81	c	0,498	ij	2,542	d	1,630c
Nishava	25,32	c	17,28	ab	10,11	e	5,48	bc	21,26	e	0,99	ab	0,605	ef	1,213	h	0,823k
Hybrid 17-2	24,96	d	14,43	i	10,40	e	5,61	bc	22,57	d	0,87	c	0,520	ij	2,005	fg	1,183i
Russalka	24,95	d	12,00	l	8,94	g	4,87	ef	16,98	i	1,59	a	0,937	a	2,417	de	1,568c
Blian	24,93	d	17,26	ab	12,30	c	4,46	i	23,53	c	0,85	c	0,552	ij	2,482	de	2,132ab
Italia x Sultanina	24,90	d	17,09	ab	12,21	c	5,68	ab	21,49	e	0,94	b	0,520	ij	0,910	hi	1,622c
Corinth Rose	24,87	d	14,92	h	11,06	d	5,85	ab	19,91	g	0,88	c	0,527	ij	2,535	d	1,423e
Kolarovets	24,82	d	17,74	ab	12,16	c	4,74	gh	23,04	c	1,01	ab	0,802	c	1,570	g	0,903k
Kondarev 10	24,51	d	15,85	d	12,59	c	4,61	i	19,90	g	0,98	ab	0,622	ef	2,790	c	1,980ab
Hybrid 23-4	24,44	d	17,70	ab	12,79	bc	3,80	ij	21,90	e	0,84	c	0,572	hi	1,832	fg	1,503d
Kishmish Hishrau	24,43	d	14,96	h	12,15	c	4,59	i	21,38	e	0,80	c	0,620	ef	0,822	i	1,823b
Hybrid 3-6	24,41	d	13,62	j	10,88	de	5,34	bc	21,50	e	1,05	ab	0,587	gh	2,223	e	1,145j
Delight	24,36	d	14,33	i	11,64	cd	5,38	bc	22,24	d	0,91	b	0,618	ef	2,668	c	1,493d
Yangier	24,35	d	15,78	d	10,96	de	4,42	i	22,10	d	0,91	b	0,720	de	2,570	d	1,970ab
Nedelchev VI-4	23,97	e	12,59	k	9,49	f	4,80	fg	20,60	f	0,72	d	0,440	j	2,165	f	1,018j
Russalka 5 A	23,74	e	15,34	f	12,59	c	4,75	gh	21,03	e	1,01	ab	0,807	c	0,518	j	0,600k
Thracian Pearl	23,71	e	17,43	ab	14,20	a	5,64	bc	20,55	f	0,90	b	0,543	ij	1,910	fg	1,393e
Flame Seedless	23,39	e	15,23	f	10,43	d	5,57	bc	21,33	e	0,90	b	0,638	ef	2,560	d	1,697b
Slavianka	23,30	e	15,16	g	10,22	d	4,93	ef	21,37	e	0,95	b	0,598	fg	0,860	i	1,465e
Hybrid 720-19	23,30	e	14,38	i	11,94	cd	4,50	i	21,23	e	0,93	b	0,617	ef	0,622	j	0,518k
Beauty Seedless	23,09	e	17,36	ab	12,32	c	6,12	ab	19,72	g	1,13	ab	0,693	de	2,512	d	2,137ab
Kishmish luchistii	23,01	e	14,25	j	10,90	de	4,50	i	19,12	g	0,84	c	0,483	ij	3,057	ab	1,680b
Hybrid 21-17-41	22,91	f	15,26	f	10,61	de	4,50	i	21,16	e	0,84	c	0,550	ij	2,070	f	1,828b
Giant	22,76	f	15,07	g	11,67	d	4,47	i	20,55	f	1,00	ab	0,633	ef	1,367	h	1,558c
Hybrid 36-16	22,73	f	12,95	k	10,62	de	4,58	i	21,28	e	0,96	b	0,578	gh	2,217	e	1,200i
Tarnau	22,15	f	14,03	j	10,81	de	4,40	i	19,00	g	0,92	b	0,830	b	2,230	e	0,500k
Focha Seedless	21,80	f	14,64	h	11,65	cd	5,29	bc	19,77	g	1,04	ab	0,708	de	2,378	de	1,452e
Russalka 5 B	21,69	f	13,84	j	11,23	d	4,96	de	24,20	b	0,79	d	0,520	ij	0,618	j	1,837b
Superior Seedless	21,68	f	12,08	l	9,48	f	4,13	i	19,61	g	0,76	d	0,513	ij	1,402	g	1,278h
Early Superior Seedless	21,47	g	13,70	j	12,38	c	4,44	i	19,30	g	0,82	c	0,578	gh	0,700	j	0,502k
Nimrang x Sultanina	21,39	g	16,26	c	12,69	bc	4,13	i	19,71	g	0,98	ab	0,678	de	0,822	**i**	0,493k
Emerald Seedless	21,30	g	11,82	l	9,66	f	4,07	i	18,66	h	0,70	d	0,507	ij	0,867	i	1,867ab
Ruby Seedless	20,88	g	12,88	k	10,32	d	4,39	i	19,02	g	1,04	ab	0,567	hi	1,272	h	1,947ab
Corinth Seedless	20,31	g	14,88	h	10,70	de	4,71	h	17,83	i	1,15	ab	0,757	c	1,707	g	0,858k
Russalka 1	20,18	g	11,85	l	9,48	f	4,12	i	17,34	i	0,67	e	0,445	j	2,307	e	1,613c
Kishmish VIRA	20,11	g	14,36	i	11,75	cd	4,65	i	19,50	g	0,97	b	0,640	ef	1,418	g	1,242h
Russalka 3A	19,03	h	16,68	c	12,27	c	4,78	fg	18,75	h	1,05	ab	0,573	hi	1,552	g	1,327g

tween the separate cultivars in these indicators are from ***a*** to ***k***, which signifies great variety in their absolute values.

The polar axis of pollen grains in the second group – known old seedless vine cultivars – is from 18.89 µm (Sultanina Muskata) to 25.16 µm (Rodi0, and the groups formed are from ***a*** to ***h*** (Table 2). The same arrangement of cultivars is also observed in the sizes of the equatorial axis, mesocolpium and apocolpium. In individual groups of proof with all the remaining cultivars, belong only those with the largest and the smallest parameters of these indicators. For equatorial axis these are: Corinth Black – 17.79 µm – ***a***, Red Seedless – 17.69 µm – ***a*** and Kishmish Muskatnii – 11.74 µm – ***i***; for mesocolpium – Rodi – 13.65 µm – ***a*** and Corinth White – 8.94 µm – ***h***, as Kishmish Muskatnii, Sermanli and Kishmish Tiurkmenskii also belong to a separate group – ***g***; for apocolpium – Rodi – 6.27 µm – ***a***, Sultanina Gigas – 5.31 µm – ***b*** and Kishmish Tiurkmenskii – 3.57 µm – ***h***. The largest colp length is the one of Kishmish Muskatnii – 23.03 µm – ***a***, and the smallest is found in Corinth White – 16.43 µm – ***g***. In this range, the differences between some of the cultivars have not been proven. In terms of colp width, the researched cultivars are more similar to each other and they form groups from ***a*** to ***e***, and in terms of colp depth – only ***a*** and ***b***. The same trend exists in the indicators pore length and width.

The results from the multiple regression analysis in the cultivar Russalka 2 show that only the factor F_2 exerts a positive direct influence (0.837) on the polar axis, and those of F_1 and F_3 – a negative one (-0.072, -0.168) (Table 3). The determination coefficient (R^2) for this cultivar is 85.7% and it expresses strong dependence of the polar axis on the surveyed indicators. In Early Superior Seedless, the direct coefficients have positive values for the factors F_1 – 0.749 and F_3 – 0.309, and for F_2 – this indicator is negative (-0.049). The determination coefficient is high – 81.1%. Through the research model in the cultivar Vita the number of indicators is reduced by excluding mesocolpium, colp width and pore width. In this cultivar, F_1 (0.747) and F_3 (0.418) have positive direct influences, and F_2 (-0.235) – a negative one. All elements of the pollen aperture complex in Nedelchev VI-4 affect moderately

Table 2

Multifactorial comparative analysis of the sizes of the most important elements of pollen aperture complex in the studied seedless vine cultivars (µm)

Second Group Cultivars	Polar axis		Equatorial axis		Mesocolpium		Apocolpium		Colp length		Colp width		Colp depth		Pore length		Pore width	
Rodi	25,16	a	17,40	ab	13,65	a	6,27	a	21,49	bc	1,04	ab	0,71	b	1,05	cd	1,77	abc
Sultanina Gigas	24,78	ab	14,59	defg	10,96	fg	5,31	b	20,17	d	0,96	de	0,61	b	2,85	a	1,33	cd
Rushaki	24,64	ab	15,32	def	11,65	def	4,42	defg	21,17	bc	0,90	de	0,64	b	2,15	ab	1,45	cd
Askeri	24,56	ab	17,21	abc	11,94	cde	5,04	bcd	22,37	ab	0,84	e	0,46	b	0,52	d	1,35	cd
Kishmish Black	24,17	abc	15,19	def	11,64	def	4,71	bcdef	21,57	b	0,96	de	0,52	b	1,16	bcd	1,57	abc
Kara Sultani	23,90	abcd	17,35	ab	12,16	cde	5,22	bcd	20,98	ed	0,95	de	0,63	b	2,70	a	1,39	cd
Kishmish Muskatnii	23,76	bcd	11,74	i	10,43	g	4,64	bcdef	23,03	a	0,94	de	0,60	b	1,05	cd	1,02	de
Corsa Kishmish	23,73	bcd	13,88	fgh	12,59	bcd	4,93	bcde	20,30	cd	0,75	e	0,61	b	0,69	d	1,61	abc
Raucha White	23,73	bcd	15,60	cdef	12,59	bcd	4,53	bcdef	20,26	cd	0,87	e	0,50	b	2,31	a	1,54	bc
Kishmish Irtishor	23,13	cd	15,58	cdef	10,81	fg	4,75	bcde	20,30	cd	0,96	de	0,61	b	0,65	d	1,52	bc
Ushaas Nazeli	22,77	de	16,25	abcd	11,67	def	5,12	bcd	19,89	d	1,16	ab	1,39	a	2,46	a	1,38	cd
Sultanina	21,78	ef	14,97	defg	10,70	fg	5,27	bc	17,90	f	1,63	a	0,94	ab	2,62	a	1,51	bc
Corinth Black	21,21	f	17,79	a	13,13	ab	5,21	bcd	19,29	de	0,91	de	0,76	b	2,14	ab	2,00	a
Sermanli	20,98	fg	12,85	hi	10,22	g	3,96	fgh	18,33	ef	0,77	e	0,48	b	2,31	a	1,58	abc
Kishmish Tiurkmenskii	20,87	fg	13,28	ghi	10,11	g	3,57	h	19,67	d	0,79	e	0,65	b	0,86	d	0,46	f
Early Kishmish	20,72	fg	14,21	efgh	11,42	ef	4,88	bcde	18,40	ef	0,80	e	0,47	b	0,70	d	1,74	abc
Kishmish Vatkana	19,94	gh	15,75	bcde	12,06	cde	5,01	bcd	18,27	ef	0,94	de	0,60	b	2,06	abc	1,94	ab
Corinth White	19,47	h	12,53	hi	8,94	h	3,75	gh	16,43	g	1,54	a	0,94	ab	2,21	ab	1,37	cd
Red Seedless	19,41	h	17,69	a	12,69	bc	4,50	cdef	18,52	ef	1,11	ab	0,61	b	1,17	bcd	0,75	ef
Sultanina Muskata	18,89	h	16,18	abcd	12,38	bcde	4,17	efgh	17,36	fg	0,72	e	0,53	b	2,46	a	1,51	bc

Table 3
Factor distribution and regression model coefficients of the indicators of pollen aperture complex in the studied seedless vine cultivars and hybrid forms

First Group Cultivars	**Russalka 2**			**Early Superior Seedless**			**Vita**			**Nedelchev VI-4**		
Factors	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	
Equatorial axis	0,842				0,896		0,987			0,900		
Mesocolpium	0,994			0,840						0,729		
Apocolpium		0,916			0,975				0,856	0,833		
Colp length			0,983	0,763			0,742			-0,739		
Colp width	-0,804			0,906							-0,732	
Colp depth	-0,730					0,982		0,957		-0,778		
Pore length			0,749		0,760			0,842			0,974	
Pore width		0,944									0,920	
Regression equation	$y=24,95-0,185F_1+2,162F_2-0,434F_3$			$y=19,201+0,567F_1-0,037F_2+0,234F_3$			$y=25,687+0,731F_1-0,230F_2+0,409F_3$			$y=23,973-0,261F_1-0,422F_2$		
Direct Path coefficient	F_1	-0,072		F_1	0,749		F_1	0,747		F_1	-0,300	
	F_2	0,837		F_2	-0,049		F_2	-0,235		F_2	-0,485	
	F_3	-0,168		F_3	0,309		F_3	0,418				
Determination coefficient	R^2	0,857		R^2	0,811		R^2	0,887		R^2	0,543	
First Group Cultivars	**Russalka 3A**			**Hybrid 21-17-41**			**Hybrid 17-2**			**Apirena di Valetri**		
Factors	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
Equatorial axis		0.791			0.861			0.861				
Mesocolpium	0.908									0.972		
Apocolpium					0.971			0.971			-0.923	
Colp length		-0.852				0.764			0.764			0.957
Colp width			0.956	0.728			0.728					
Colp depth		-0.742				-0.926			-0.926			0.862
Pore length	0.713			0.951			0.951				0.801	
Pore width	0.923			-0.847			-0.847			0.976		
Regression equation	$y=19.032-0.304F_1-0.049F_2+0.133F_3$			$y=22.906-0.930F_1+0.307F_2+0.233F_3$			$y=22.91-0.930F_1+0.307F_2+0.233F_3$			$y=27.238+0.308F_1-0.278F_2-0.325F_3$		
Direct Path coefficient	F_1	-0.639		F_1	-0.707		F_1	-0.707		F_1	0.472	
	F_2	-0.102		F_2	0.233		F_2	0.233		F_2	-0.426	
	F_3	0.281		F_3	0.177		F_3	0.177		F_3	-0.498	
Determination coefficient	R^2	0.705		R^2	0.765		R^2	0.765		R^2	0.808	

Table 4
Factor distribution and regression model coefficients of the indicators of pollen aperture complex in the studied seedless vine cultivars

Second Group	Rodi			Kishmish Muskatnii			Kishmish Irtishor			Corinth Black			Corinth White		
Cultivars	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3	F_1	F_2	F_3
Equatorial axis		0.983				0.844	0.805			0.892			-0.976		
Mesocolpium	0.864				-0.901		0.861			0.873			0.856		
Apocolpium		0.988		-0.958				0.765			-0.901				0.949
Colp length	0.968					-0.772		0.918				0.889	0.923		
Colp width	-0.822				0.969			0.929				0.899		0.777	
Colp depth	-0.871					0.815	-0.826			-0.960				0.710	
Pore length			0.922	0.856					-0.961		0.926			0.945	
Pore width		-0.772		0.889			0.803				0.803	w		0.751	
Regression equation	$y = 25.163 - 0.512F_1 + 0.203F_2 - 0.120F_3$			$y = 23.760 + 1.357F_1 + 0.230F_2 + 0.498F_3$			$y = 23.125 + 0.584F_1 + 1.148F_2 + 0.148F_3$			$y = 21.205 + 0.051F1 + 0.107F_2 + 0.199F_3$			y = 19.467 + 0.497F1 + 0.933F2 – 0.564F3		
Direct Path coefficient	F_1	-0.795		F_1	0.906		F_1	0.431		F_1	0.176		F_1	0.395	
	F_2	0.316		F_2	0.153		F_2	0.846		F_2	0.367		F_2	0.740	
	F_3	-0.187		F_3	0.332		F_3	0.109		F_3	0.681		F_3	-0.448	
Determination coefficient	R^2	0.876		R^2	0.977		R^2	0.955		R^2	0.793		R^2	0.951	

negatively the variation of polar axis length. The factor F_3 has a positive value of the direct Path coefficient in Russalka 3A (0.281), and the variation in colp width is of the greatest significance for the variable value. The apocolpium is excluded from the model for this cultivar. In Hybrid 21-17-41 and Hybrid 17-2, the factors F_2 and F_3 exert a positive direct influence on polar axis parameters. The indicators of factor F_1 have a negative direct impact in both cultivars, in which the reduction covers only the mesocolpium. In Apirena di Valetri, the indicators of factor F_1 (0.472) affect directly positively the sizes of the polar axis, and F_2 and F_3 – negatively. The equatorial axis and colp width are excluded from the surveyed indicators. By means of the applied investigation model, it has been found that in all cultivars, with the exception of Nedelchev VI-4, the variations of polar axis parameters are mainly due to the indicators summarized in the relevant factors.

The factor distribution and coefficients of the regression model for the second group of cultivars show that there is a diversity of the indicators determining the variability of the polar axis of pollen grains (Table 4). Determination coefficients are high – from 79.3% (Corinth Black) to 97.7% (Kishmish Muskatnii), and they indicate that the dependence of the variable value on the indicators included in the study, is high. In the cultivar Rodi, the direct coefficient of the factor F_2 has a positive value – 0.316, and the indicators which influence the length of the pollen polar axis are: equatorial axis, apocolpium and pore width. The cultivars Kishmish Muskatnii, Kishmish Irtishor and Corinth Black are characterized by positive direct influences of the three factors – F_1, F_2, F_3, and F_3 has a negative direct impact in Corinth White. In the cultivars from the second group as well, the variations in polar axis parameters are predominantly a result of the indicators summarized in the relevant factors.

Conclusions

1. Statistically proven differences exist in the dimensions of the most important elements of pollen aperture complex in the studied seedless cultivars and hybrid vine forms. The statistical groups formed according to the individual indicators are specific for each cultivar, and they completely reflect the observed palynobiometric polymorphism.

2. All studied indicators of the ultrasculptural ornamentation of the pollen exine influence the variability of polar axis length in the two conditional groups of cultivars. Its dependence on the variation of equatorial axis parameters and colp length is the strongest.

Fig. 1. Submicroscopic structure of pollen exine in the cultivar Raucha White – polar axis exposure

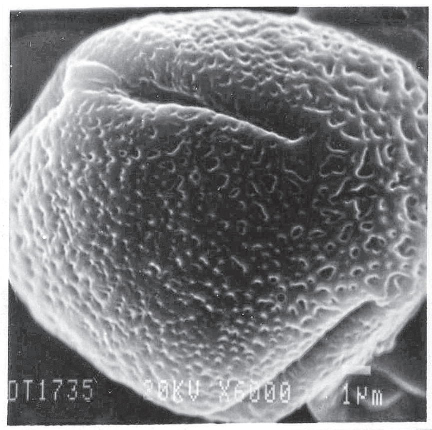

Fig. 2. Ultrastructure of pollen exine in the cultivar Tarnau – equatorial axis exposure

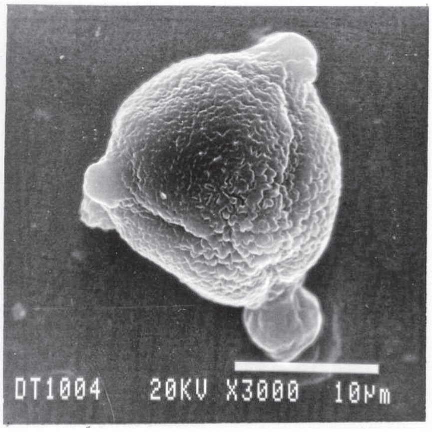

Fig. 3. Ultrasculpture organization of pollen exine in the cultivar Sultanina – mesocolpium and apocolpium exposure

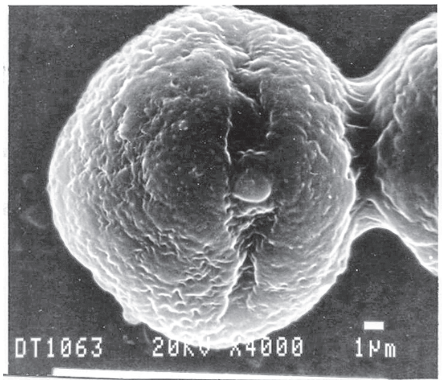

Fig. 4. Microrelief of pollen exine in the cultivar Nedelchev VI-4 – colp length, pore length and width exposure

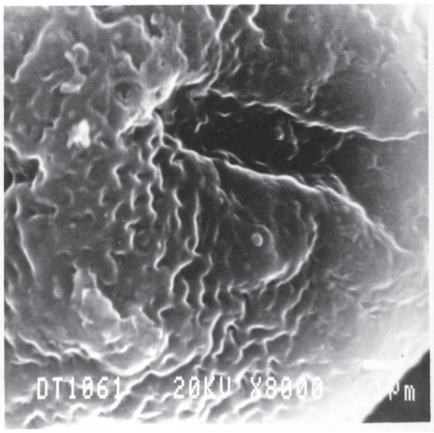

Fig. 5. Submicroscopic aspect of pollen exine in the cultivar Kishmish VIRA – colp width exposure

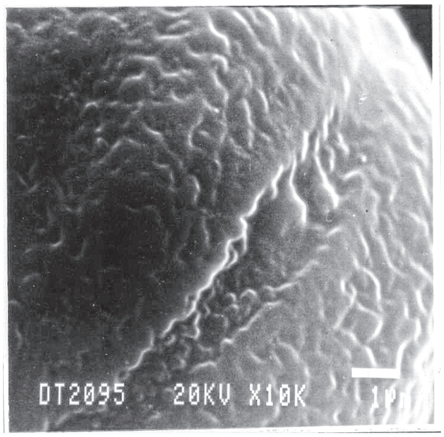

Fig. 6. Ultrasculpture of pollen exine in the cultivar Askeri – colp depth exposure

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