Productivity and harvest quality of varieties and hybrid forms of grapes in the conditions of the Caspian-Caspian subprovince of the Republic of Dagestan

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Abstract. This article discusses issues related to the productivity and quality of grape varieties of various ecological and geographical origins collected in the ampelographic collection of the Dagestan Breeding Experimental Station for Viticulture and Vegetable Growing. The object of research is 104 grape varieties. Of the 104 varieties included in the study, 22 varieties were of intraspecific hybridization of Vinis vinifera, 67 varieties of interspecific hybridization (65 of European-American, 5 of European-Asian and 3 of European-American origin), 6 varieties of Vinis vinifera as a control. The study of the biological properties of these varieties is important for identifying and using sources of valuable traits. In the group of table varieties, the highest grape yield was from interspecific hybrids: Dekabrsky -19.5 kg/bush; SV-12-304- 17.9; SV-20-365-11.2; SV-23-657-12.8; XI-36-6/100 -12.9 kg/bush. In the group of technical varieties, according to yield per bush, the following are distinguished: TSKHA-3 - 22.2 kg/bush; Pierrel -19.7 kg/bush; Bianca-13.4 kg/bush; SV-20-473 - 13.2 kg/bush; Strogozia -12.9 kg/bush; Gift of Magarach - 15.2 kg/bush; SV-12-375- 12.4 kg/bush. Among the table varieties, the interspecific hybrids SV-12-304 - 529 g, SV-20-365-330 g, SV-12-309 - 315 g and Lakhedi mezesh - 313 g are distinguished by bunch weight. Of the technical varieties, by bunch weight the following varieties stood out: TSKHA-3 -322 g; Pierrel -319 g; SV-23-40 – 288 g; SV-20-473-286. The results obtained contribute to the effective use of grape genetic resources in scientific research.

1 Introduction

Industrial viticulture in the Russian Federation is developed in the Southern and North Caucasus regions, where favorable conditions exist for varieties of all ripening periods and directions of use [2].

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As a result of the positive dynamics of industry development, in recent years the area under grape plantings has increased by 33.8 thousand hectares, the increase in gross yields amounted to 342.2 thousand tons, and the yield increased by 22.2 c/ha. This was facilitated by the introduction of modern cultivation technologies and grape varieties that are most adapted to the soil and climatic conditions of cultivation [3].

Currently, all over the world, including in Russia, much attention is paid to the study of autochthonous grape varieties and the formation of assortments [3, 6, 7, 16, 22].

In connection with climate change, there is increasing interest in studying the responsiveness of grape varieties to these changes.

The use of varietal agricultural technology in growing grapes makes it possible to achieve the most complete realization of the potential of economic productivity in the conditions of a specific area [17]. The use of agrotechnical techniques makes it possible to control the ontogenesis of grape plants and regulate the quality of the resulting products for fresh consumption and wine production [14-15, 23-25].

The main direction in the selection of grape varieties is the ability to expand the terms of consumption of fresh grapes by breeding varieties of different ripening periods, improving quality indicators, increasing yields and the adaptive ability of new genotypes to the conditions of the cultivation region [10]. Success in creating new promising high-quality grape varieties largely depends on the diversity of the source material. The genetic diversity of samples from the ampelographic collection of the Dagestan Breeding Experimental Station for Viticulture and Vegetable Growing (DBESVaVG) differs in the direction of use, product quality, adaptability to biotic and abiotic environmental factors, and other valuable economic traits. Of the 104 varieties included in the study, 22 varieties were of intraspecific hybridization of Vinis vinifera, 67 varieties of interspecific hybridization (65 of European-American, 5 of European-Asian and 3 of European-American origin), 6 varieties of Vinis vinifera as a control. Among the hybrid varieties and breeding forms studied: 30 - Moldavian selection, 20 - Crimean, 5 - Hungarian, 25 - Russian, 6 - Bulgarian, 6 - French selection.

Identification of sources of valuable traits for breeding and the best varieties of the collection to recommend their use in production requires knowledge of the source material [5, 18].

At the present stage of development of viticulture, the problem of collecting, preserving, studying and using genetic resources of grapes is extremely important.

The purpose of our research is to characterize the productivity and quality of the harvest of grape varieties of various ecological and geographical groups in order to identify and use sources of valuable traits that are maximally adapted to the conditions and needs of the Republic of Dagestan.

2 Materials and methods

The place of research is the ampelographic collection of the FGBNU "Dagestan Breeding Experimental Station for Viticulture and Vegetable Growing" - a branch of the FGBNU "North Caucasus Federal Scientific Center for Horticulture, Viticulture and Winemaking", which is located in the Primorsky-Caspian subprovince of the Republic of Dagestan (Derbent). The objects of research were introduced varieties and locally bred varieties, a total of 104 grape varieties. Agrotechnical care is carried out according to the rules generally accepted for this viticulture region.

The study of crop productivity and quality was carried out in 2010-2020. The following methods were used in the work: “Methods of botanical description and agrobiological study of grape varieties” [8]; “Methodology for ampelographic description and agrobiological study of varieties”[11]; “Methodological recommendations for technological assessment of

grape varieties for winemaking"[1]. Tasting assessment of table grape varieties was carried out using a 10-point system in accordance with methodological recommendations for the storage of fruits, vegetables and grapes [1]. General statistical processing of the data was carried out according to methods accepted in breeding and genetics using standard Microsoft Office programs [9].

3 Results and Discussion

The grape harvest is the most important indicator of the productivity of a variety. This indicator mainly depends on the number and weight of bunches. The formation of the yield on bushes is dominated by the biological characteristics of the variety, environmental conditions of production and agrotechnical methods of cultivating plantings.

In terms of the size of the grape harvest, the studied groups of table and industrial varieties had certain differences during the years of research.

On average, over 10 years of observation, the yield per bush for the group of table and technical varieties was 7.8 kg.

There were contrasting differences in grape yield per bush within each group between individual varieties.

Table 1. Productivity of varieties and hybrid forms of the table area (average for 2010-2020).

Variety name	Number of eyes on a bush, pcs.	Shoots developed, %	Fruitful shoots,%	Coefficient		Bunch weight, g	Productivity		Mass concentration		Productivity index, Sp, g
				Fruiting, K_1	Fruitfulness, K_2		C 1 bush, kg	C 1га, т	Sugars, g/100cm³	Acids, g/dm³	
1	2	3	4	5	6	7	8	9	10	11	12
SV-12-304	46	71	88	1.03	1.17	529	17.9	39.8	14.1	9.2	544.8
SV-12-309	38	72	71	0.75	1.10	315	6.6	14.6	15.7	8.2	189.0
8G-2	41	86	71	0.71	1.04	126	3.2	7.1	21.2	5.6	126.5
SV-20-365	60	80	70	0.71	1.03	330	11.2	24.8	14.2	9.0	217.8
Gechei zamatosh'	40	75	73	0.77	1.15	150	3.4	7.6	14.3	9.6	115.5
Lakkhedi mezesh'	41	87	76	0.75	1.00	313	8.4	18.6	15.6	11.0	234.7
Yalovenskiy ustoychivyy	43	93	90	1.07	1.19	169	7.3	16.2	17.5	8.3	287.3
Vertesh' chilaga	56	81	71	0.71	1.00	267	8.5	18.8	14.9	9.5	184.2
XIV-3-46/100	45	90	72	0.73	1.03	162	4.8	10.6	16.5	9.0	118.2
XIV-1-64/100	44	86	80	0.67	1.13	178	6.1	13.6	16.8	9.1	158.4
TsGL -10	28	83	76	0.79	1.06	154	2.9	6.4	19.6	6.6	121.6
Srebrostruy	47	71	78	0.94	1.23	267	8.5	18.8	16.0	8.6	250.9
SV-23-657	50	88	84	1.18	1.41	248	12.8	28.4	14.0	9.4	292.6
XV-18-55	42	85	67	0.67	1.00	213	5.1	11.3	17.2	9.0	238.5
Chambourcin	36	80	75	0.96	1.27	245	6.8	15.1	15.7	8.2	235.2
XIV-28-16	51	87	79	0.86	1.08	179	6.9	15.3	15.1	9.5	153.9
TSKHA 1	45	83	69	0.71	1.03	132	3.6	7.9	23.9	5.6	93.7
TSKHA 2	31	80	72	0.92	1.27	250	5.8	12.8	15.5	10.5	230.0
"D"	45	87	55	0.64	1.19	257	6.4	14.2	14.7	9.0	172.1
V-95-1	51	94	78	1.00	1.29	181	8.6	19.1	15.8	9.5	181.0
"11"	43	91	73	0.95	1.31	231	8.8	19.6	14.2	10.6	219.4
3 Г-3	27	86	59	0.62	1.07	100	1.5	3.3	18.5	8.1	62.0
Dekabr'skiy	57	92	89	1.33	1.51	276	19.5	43.3	14.4	10.1	281.5
TsGL -2	58	89	66	0.69	1.05	277	9.9	21.9	16.9	8.6	191.1
Vierul 2	35	87	54	0.68	1.23	129	2.7	5.9	16.3	8.0	87.7
XI-36-6/100	56	89	78	0.94	1.21	276	12.9	28.6	14.8	9.1	259.4
XI-38-74	44	94	78	0.92	1.18	160	6.2	13.8	18.4	9.0	147.2
XX-19-66/100	53	79	82	0.88	1.08	249	9.2	20.4	17.1	10.4	219.1
"B"	68	86	56	0.62	1.12	199	7.4	16.4	14.1	10.3	123.4
Karaburnu (control)	62	85	79	0.86	1.09	231	10.6	23.6	17.1	11.0	198.6
HCP_{05}	2.0	1.3	1.9	0.03	0.02	17.2	0.85	1.88	0.46	0.27	18.40

In the group of table varieties (Table 1), the highest grape yield was from interspecific hybrids: Dekabrsky -19.5 kg/bush; SV-12-304- 17.9; SV-20-365-11.2; SV-23-657-12.8; XI-36-6/100 -12.9 kg/bush. The maximum amplitude of variation in yield per bush for all table varieties and hybrid forms ranges from 1.5 to 19.5 kg/bush. In the group of table varieties, the lowest yield indicators were for hybrids 3G-3-1.5 kg/bush; 8G-2-3.2 kg/bush; TSKHA 1- 3.6 kg/bush; TsGL-10-2.9 kg/bush; Hechei zamatosh variety - 3.4 kg/bush.

In the group of technical varieties (Table 2), according to the yield per bush, the following are distinguished: TSKHA-3 - 22.2 kg/bush; Pierrel -19.7 kg/bush; Bianca-13.4 kg/bush; SV-20-473 - 13.2 kg/bush; Strogozia -12.9 kg/bush; Podarok Magarach - 15.2 kg/bush; SV-12-375- 12.4 kg/bush.

Table 2. Productivity of technical varieties and hybrid forms (average for 2010-2020).

Variety name	Number of eyes on a bush, pcs.	Shoots developed, %	Fruitful shoots, %	Coefficient		Bunch weight, g	Productivity		Mass concentration	
				Fruiting, K1	Fruitfulness, K_2		C 1 bush, kg	C 1 ha, t	Sugars, g/100cm^3	Acids, g/dm^3
1	2	3	4	5	6	7	8	9	10	11
Bianca	63	82	87	1.36	1.58	189	13.4	29.7	18.1	9.3
Dunavsky Lazur	46	66	65	1.12	1.37	131	2.9	6.4	16.3	8.2
XIV-2-32	48	87	58	0.76	1.31	158	4.6	10.2	15.5	10.5
TSKHA 9	48	68	69	0.84	1.21	132	3.7	8.2	16.7	9.6
SV-23-40	44	85	90	1.47	1.65	288	16.1	35.7	14.1	10.7
SV-20-473	41	86	90	1.27	1.44	286	13.2	29.3	14.0	9.4
XV-18-65	53	91	83	1.12	1.34	190	10.4	23.1	14.9	9.7
XI-36-34	42	88	90	1.21	1.36	219	9.8	21.8	14.7	9.3
Strogozia	51	89	89	1.23	1.39	227	12.9	28.6	15.1	9.6
Misia	47	77	72	0.77	1.07	223	6.2	13.8	15.6	8.9
Antey	57	79	58	0.68	1.22	236	7.8	17.3	15.8	9.5
V-102-36	43	92	59	0.72	1.21	168	4.7	10.4	16.3	9.8
TsGL -1	35	81	58	0.74	1.12	88	1.6	3.6	22.7	6.9
"B"	52	86	80	1.08	1.36	172	8.4	18.6	17.5	7.2
TSKHA 3	71	88	85	1.09	1.28	322	22.2	49.3	14.2	9.0
"G"	57	88	70	0.74	1.06	99	3.7	8.2	18.1	7.6
Strugurash	40	79	61	0.77	1.26	206	4.9	10.8	14.4	8.6
Levokumskiy ustoychivyy	65	81	76	0.86	1.15	224	10.1	22.4	14.6	9.3
"A"	36	84	72	0.80	1.14	176	4.2	9.3	14.4	8.6
Viorica	41	89	86	1.21	1.41	129	5.8	12.8	16.7	7.3
XIV-19-55	57	90	66	0.73	1.11	213	8.1	17.9	17.2	9.0
TSKHA - 10	61	92	89	1.17	1.31	184	12.3	27.3	15.5	9.8
TSKHA - 16	46	90	82	1.14	1.41	91	4.4	9.7	17.1	10.5
Stepnyak	48	88	61	0.83	1.40	129	4.5	9.9	16.9	8.6
III-75-89	48	85	79	0.95	1.22	214	8.3	18.4	17.2	9.0
III-51-69/100	41	92	73	0.78	1.07	160	4.8	10.6	14.9	9.6
V-103-22	59	89	82	1.09	1.34	126	7.3	16.2	17.6	9.3
"ZH"	52	87	76	0.82	1.08	101	3.8	8.4	19.3	6.2
XI-41-22	67	82	71	0.81	1.15	178	8.0	17.8	16.5	8.4
Pierrel	55	86	89	1.29	1.44	319	19.7	43.8	14.2	9.0
V-14-72	54	87	84	1.10	1.33	114	5.9	13.1	17.9	8.0
XV-50-12	50	93	81	0.85	1.05	223	8.9	19.8	19.6	8.2
XIX-2-32/100	38	88	67	0.73	1.08	181	4.5	9.9	15.2	8.8
III-57-15/100	37	85	83	1.18	1.41	163	6.2	13.8	17.7	7.5
XXI-37-52	52	86	91	1.48	1.63	177	11.8	26.2	15.7	9.1
V-18-46	41	87	92	0.88	1.45	181	5.8	12.8	17.4	8.3
III-75-89/100	48	86	91	1.28	1.42	165	8.9	19.8	16.3	9.8
XIV-11/44/100	47	86	92	0.95	1.03	189	7.4	16.4	15.5	9.3
X-2-89/100	43	87	84	1.07	1.28	180	7.4	16.4	16.6	9.6
XI-36-43	43	85	88	1.19	1.34	185	7.9	17.5	14.8	9.5
XIV-11-57/100	66	89	92	1.30	1.43	148	11.4	25.3	17.7	9.8
XXI-16-36	48	85	88	1.31	1.50	136	7.3	16.2	18.9	8.4
V-103-23	58	87	95	1.37	1.46	143	10.0	22.2	17.6	9.1
XV-25-60/100	53	89	96	1.41	1.48	132	8.9	19.7	18.2	8.9
XV-17-5	43	87	93	1.34	1.46	179	9.1	20.2	16.9	8.4

XV-50-12	44	89	90	1.25	1.38	158	7.9	17.6	16.6	8.7
XV-13-12/100	67	87	88	1.11	1.40	165	10.8	23.9	15.9	9.6
X-36-42	47	80	67	0.89	1.36	170	5.8	12.8	17.6	10.8
X-2-89	55	88	92	1.28	1.40	167	10.5	23.3	18.3	8.7
XX-17-22/100	27	85	90	1.34	1.47	149	4.6	10.2	18.6	8.9
XIV-1-27	56	85	91	1.12	1.22	136	7.3	16.2	18.2	8.9
V-102-49	59	86	88	1.21	1.38	102	6.3	13.9	19.0	8.0
XI-37-02/100	48	80	93	1.30	1.42	126	6.4	14.2	22.7	9.2
XV-50-12	46	86	90	1.15	1.28	164	7.5	16.6	18.3	8.7
6 G-2	55	84	84	0.97	1.18	96	4.4	9.8	19.5	7.7
Trapezitsa	55	76	82	1.02	1.26	218	9.4	20.8	15.6	8.9
5-G-2	51	86	83	0.81	1.00	203	7.3	16.2	18.9	8.2
Mattress 9-G-2	49	81	71	0.79	1.14	141	4.4	9.7	18.0	11.0
2 G-3	38	85	76	0.87	1.16	164	4.8	10.6	16.7	9.9
Tavkveri 4G-3	45	75	65	0.72	1.14	200	4.8	10.6	17.1	8.8
7G-2	47	79	85	0.75	1.13	202	5.4	11.9	18.6	8.3
1G-3	46	86	67	1.00	1.47	85	2.6	5.8	18.4	8.8
Podarok Magarach	63	83	95	1.50	1.60	190	15.2	33.8	15.5	9.8
CB-12-375	56	85	84	1.04	1.25	247	12.4	27.6	15.8	9.5
Yubileynyy Magaracha	51	88	89	1.37	1.56	126	7.8	17.3	18.1	9.1
XXIV-1-86	51	84	82	1.00	1.22	138	5.9	13.1	14.0	10.2
Saperavi	51	82	85	1.02	1.19	99	4.2	9.3	18.7	8.3
Koarne negre	68	85	62	0.79	1.27	169	7.8	17.3	15.4	9.5
Pervenets Magaracha	54	87	91	1.17	1.34	179	9.8	21.8	16.9	8.4
Muscat white (control)	32	76	65	0.76	1.18	131	2.4	5.3	19.9	6.6
HCP_{05}	1.8	1.0	2.2	0.04	0.03	10.3	0.78	1.73	0.37	0.19

The lowest yields per bush were observed in varieties and hybrid forms: 1G-3 – 2.6 kg/bush; TsGL-1 – 1.6 kg/bush; Dunavsky azure - 2.9 kg/bush; "G" - 3.7 kg/bush; "F" - 3.8 kg/bush; Muscat white (control) -2.4 kg/bush.

The maximum amplitude of variation of the trait between the highest and lowest indicators in this group of varieties was equal to 20.6 kg/bush, with the average yield for the group of technical varieties being 7.8 kg/bush.

As is known, the mass of a bunch of grapes determines the productivity of the shoot, the yield per bush and the yield of plantings per unit area. The size of the bunch depends on many natural and anthropogenic factors. The main determining condition for the size of the bunch is the biological characteristics of the variety.

As can be seen from the data obtained, the studied groups of table and technical varieties differed significantly in the weight of bunches: it was greatest in table varieties compared to technical varieties. The weight of a bunch of table varieties averaged 224.4 g, and of technical varieties - 171.2 g. The excess weight of bunches of table varieties over technical varieties was 24.7%. In the group of table varieties, the largest mass of bunches was found in interspecific hybrids SV-12-304 - 529 g, SV-20-365-330 g, SV-12-309 - 315 g and Lakhedi mezesh - 313 g.

The mass of the bunch of other varieties and hybrids varied from 100 to 529 g, the amplitude of variation was 429 g. For the eastern group variety Karaburnu (control), the average bunch weight was 231 g.

In the group of technical varieties, the average weight of a bunch was 171.2 g. The highest weight of bunches was in the following varieties: TSKHA-3 -322 g; Pierrel -319 g; SV-23-40 – 288 g; SV-20-473-286 g. In other varieties and hybrids, the average bunch weight varied from 85 to 247 g. The amplitude of variation in bunch weight was 234 g. As in the group of table varieties, the most contrasting differences in bunch weight were within each group between separate varieties.

In general, all studied varieties and hybrid forms in the conditions of the Primorye-Caspian subprovince provided fairly high yields. Simultaneously with the yield, such quality indicators as the mass concentration of sugars and titratable acidity were determined. As the data obtained show, a high sugar content in table varieties was noted in berries of hybrid forms: 8G-2, TSKHA-1; technical: TsGL-1, XI-37-02-100, (22.7 g/100

cm^3). In 44 varieties, the mass concentration of sugars ranged from 14 to 16 g/100 cm^3, in 56 – from 16 to 19 g/100 cm^3 and higher, and in 4 varieties in the range of 20-23 g/100 cm^3.

The total acidity of ripe grape must varies from 5.6 g/dm^3 (TSKHA-1, 8G-2) to 11 g/dm^3 (9 G-2, Karaburnu, Lakhedi mezesh). Under research conditions, the reduction in acid content, in our opinion, is ensured by the low amplitude of air temperature fluctuations during the day and night hours. The increased acid content in the conditions of the Primorye-Caspian subprovince in the studied varieties plays a positive role, with a corresponding sugar content in the berry juice.

We have derived correlations between the harvest and its components (Figure 1).

Our research clearly shows the dependence of yield on the number of bunches, which is expressed by the regression equation y = 0.4022X + 2.4383, with r = 0.84. The effect of bunch weight is not visible (r = 0.022) (Figure 1). As yield increases, quality decreases. There is a negative correlation between yield and sugar content, which is expressed by the equation y = 0.0944X + 20.228, with r = 0.49 (Figure 3).

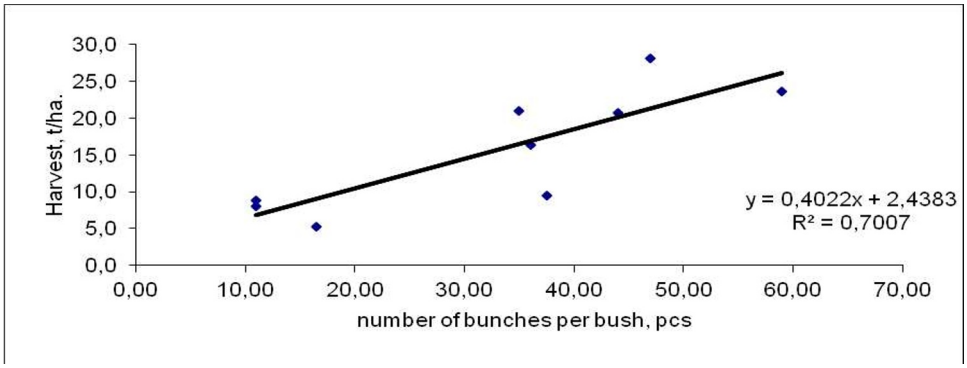

Fig. 1. Relationship between yield and number of bunches.

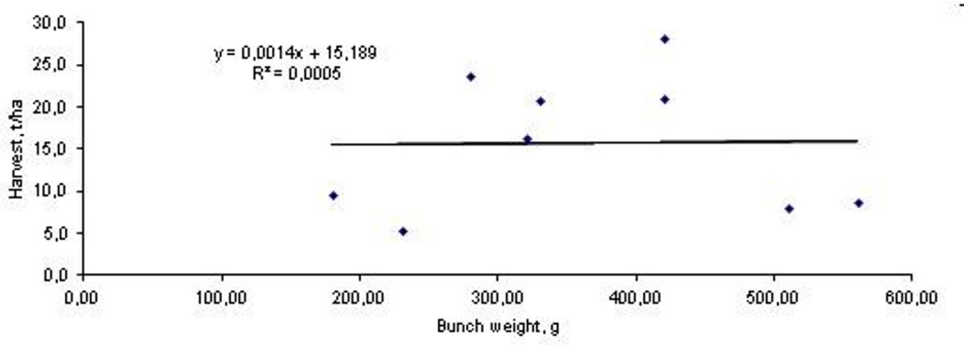

Fig. 2. Relationship between yield (t/ha) and bunch weight (g).

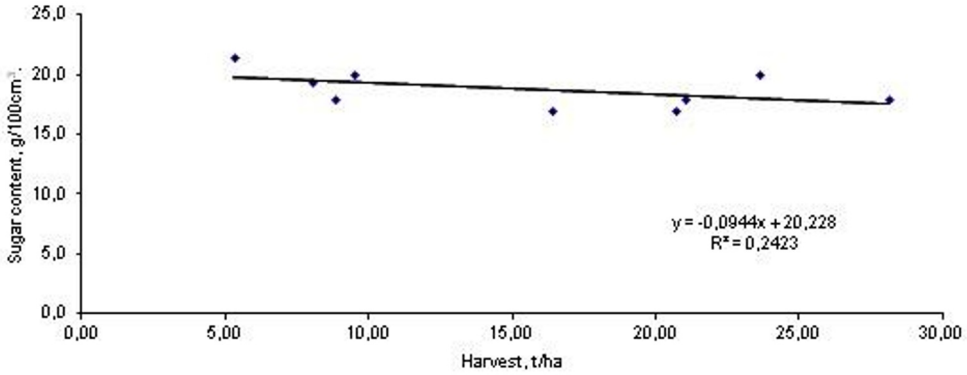

Fig. 3. Relationship between yield and sugar content.

The productivity index (shoot productivity) is the mass of bunches harvested per one developed shoot on a bush. This indicator is an important characteristic of the variety, its potential productivity and largely depends on the number and weight of the bunches. According to the productivity index, the studied groups of table and technical varieties, different in ecological and geographical origin, differed significantly and were determined for the most part by their biological characteristics.

4 Conclusion

On average, over 10 years of research, the highest productivity index was in table varieties compared to industrial varieties. The shoot productivity of table varieties averaged 197.5g/shoot, and of technical varieties - 168.5g/shoot. The excess productivity of shoots of table varieties over technical varieties was 17%. In the group of table varieties, the highest productivity index was in interspecific hybrids - from 235.2 g/shoot for Chambourcin to 544.8 g/shoot for SV-12-304. The highest productivity index exceeded the lowest shoot productivity by almost 4.8 times. The most contrasting differences in the productivity index were within each group between individual varieties.

In the group of interspecific hybrids studied, the highest shoot productivity was in the hybrid SV-12-304 (544.8 g/shoot). The hybrid 3G-3 has the smallest (62.0 g/shoot). The maximum amplitude of variation in the trait between the highest and lowest values was 451.1 g/shoot.

In the group of technical varieties, the highest shoot productivity was in the TSKHA-3 variety (350.9 g/shoot). The amplitude of variation of the trait between the highest and lowest values was 393.6 g/shoot.

The most contrasting differences in shoot productivity were within the individual cultivars within the group.

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