Production weight and its variability in 24 apricot genotypes over six years

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ABSTRACT: Productivity and its stability were evaluated in a set of 24 apricot genotypes of the world collection and some promising new selections in 1994–1999. The productivity of most genotypes was higher than that of control variety Velkopavlovická LE-6/2. Genotypes with higher productivity in the years favorable for apricot productivity gave higher yields also in the years unfavorable for productivity. It was proved by a significantly close highly significant correlation ($r = 0.64^{++}$). It is a reason for the necessary regulation of fruit set in highest-yielding varieties in the years favorable for apricot productivity when overproduction and undesirable reduction in the fruit size occur. The variability of yields in kg per tree, expressed by coefficients of variation over a six-year period, was high in the years of observation. The variability of yields was significantly lower in the years favorable for apricot productivity. To express yield variability the coefficient of variation and index of fluctuation can be used. Their similar conclusiveness was proved by the significant positive closeness of correlation between the values determined by both calculations ($r = 0.51^{+}$). The varieties Vynoslivyj and Volšebnyj showed the highest and most stable productivity. From the producer's and breeder's aspects, of these two the Vynoslivyj variety is one of the most remarkable genotypes of the evaluated set due to its fruit quality and late ripening.

Keywords: apricot; genotypes; production weight and stability; variability of individual yields; coefficient of variation; index of yield fluctuations; correlations between years

Apricots are a fruit species requiring favorable natural conditions. They are sensitive to weather conditions (particularly to temperatures) in early spring and in the blooming period. Throughout the world there is a search for spontaneous genotypes and for genotypes from intentional selection that would be adapted in a better way to different conditions from those the species have had at the centers of its origin for centuries. Fundamental requirements that are a result of the action of many internal and external factors involve high productivity and its stability. The level of yields and their regularity are crucial traits for practical use of the variety and for the use of genotypes in breeding programs. Worldwide there has appeared a number of new genotypes produced by intra- and interspecific hybridization that comply with the criteria of fruit quality and other characteristics such as appropriate growth, resistance to pathogens, etc. Any genotype in the given ecological conditions has to meet the basic requirements for high and regular productivity (Pedryc, Kerek 1999; Vachůn 1999; Guerriero et al. 1999; Fajt et al. 1999; Audergon et al. 1999; Papanikolaou-Pavlopoulou et al. 1999; Plazinič et al. 1999; Szabo et al. 1999; Vachůn et al. 1999; Benediková 2000).

Taking into account the variability of weather conditions in particular years, many-year evaluations are necessary to obtain objective results (Bassi, Karayiannis 1999). It is difficult to compare the results of the evaluated sets because the conditions of experimental localities are different and one or several common control varieties are very often missing.

The objective of the paper was to evaluate differences in the productivity of one set of apricot genotypes over a six-year period at one locality in comparison with Velkopavlovická control variety. Correlations between data on the production weight in particular years were also evaluated and promising genotypes for practical and breeding use were selected.

MATERIAL AND METHODS

An experimental orchard was established in spring 1991 at Lednice locality situated in the warmest region of the Czech Republic. Apricot (*Prunus armeniaca* L.) seedlings were used as rootstocks. The majority of genotypes came from the Czech Republic, others from the Slovak Republic, Canada and Ukraine. The numerals after the genotype name designate clone and/or breeding

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number. Selected crosses (hybrids) are designated by working numbers where the letters LE and M indicate the origin from the Faculty of Horticulture at Mendel University of Agriculture and Forestry at Brno – Lednice. Velkopavlovická LE-6/2 variety was used as control. New genotypes (designated by abbreviations M, LE, LE-SEO and numerals) were included in the experimental orchard because they were interesting after previous evaluations from the producer's aspect. The other varieties were used for a comparison on the basis of evaluation and recommendation of foreign institutions that provided these varieties for this experiment.

Trees were planted in a long block design: five plants of each genotype were set out. Each tree was evaluated individually. Out of the originally planted 93 genotypes only those genotypes were included in final evaluation whose number of plants did not decrease below three trees by the end of experiment (1999) and whose values of all studied traits were complete in all years. The number of genotypes that could be evaluated decreased to 24. This set was evaluated in the present paper. Commercially important yields were produced from the fourth year after planting. Productivity was not regulated by fruit thinning during the six-year period of evaluation.

Even though the long-term values of average annual temperatures are favorable for the experimental locality (9.0°C), there were significant differences between the years in the course of temperatures particularly in the blooming period. Four years in the period of observation (1994, 1995, 1996 and 1999) were favorable for productivity. As for temperatures in the blooming period, the experimental years can be described as follows: 1994 was a year of the first commercially important production. In that year, and in the subsequent year, there were days with lower temperatures during the blooming period but the temperatures were always above zero. In 1995 April temperatures fell to –1.1°C only once. In 1996 the blooming of apricot trees was relatively late (in the first decade of April) and no frosts causing damage occurred. The year 1999 was extraordinarily favorable for apricots and bumper yields were achieved. In 1997 and 1998 cold weather, or harmful frosts during blooming or soon after blooming not allowing pollination and fertilization, unfavorably influenced productivity. In 1998 there were several days with temperatures only 3–6°C above zero, affecting adversely the process of pollination and fertilization. In 1997 the temperatures during blooming fell to –3.2°C at two meters above the ground and caused great damage.

Production weight was determined by an individual estimate of yield in kg from each tree. Performance per tree in comparison with control variety Velkopavlovická was also evaluated by a point system according to the classifier for apricots (NITRANSKÝ 1992). According to this method, the productivity of control variety Velkopavlovická is taken as 100% with point evaluation 6. Productivity above 120% is assigned nine points. To evaluate the variability of production weight coefficient of variation and index of yield fluctuation were used. Index of fluctuation is considered to mean a sum of differences in the values of production weight between the pairs of adjacent years divided by the sum of these

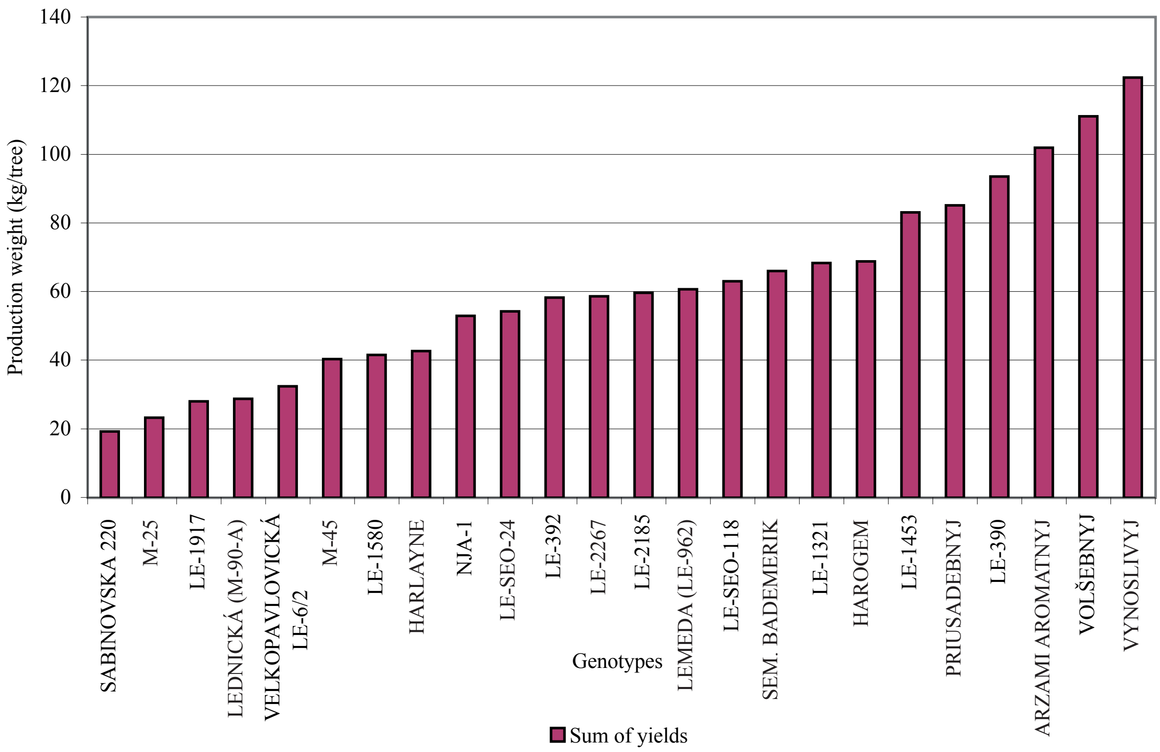

Fig. 1. Sum of yields in kg per tree in apricot genotypes over the six-year period 1994–1999

Table 1. Production weight in kg per tree in apricot genotypes and its variability in 1994–1999

Genotype	Year						Sum (kg/tree)	Average (kg/tree)	Coefficient of variation	Index of fluctuation
	1994	1995	1996	1997	1998	1999				
Velkopavlovická LE-6/2*	0.22	2.00	7.20	0.40	0.18	22.40	32.40	5.40	147.93	95.06
Harlayne	0.24	11.02	7.00	1.10	0.26	23.00	42.62	7.10	114.66	92.49
Sem. Bademerik	1.75	2.88	8.25	2.50	2.38	48.25	66.00	11.00	152.72	79.92
Priusadebnyj	4.40	17.02	18.00	0.34	2.40	43.00	85.16	14.19	102.88	83.23
Arzami aromatnyj	0.14	23.20	8.60	7.40	5.00	57.60	101.94	16.99	114.68	75.40
Volšebnyj	0.32	28.40	17.20	1.13	13.25	50.75	111.05	18.51	93.58	73.53
Vynoslivyj	0.14	34.00	8.20	6.00	16.80	57.20	122.34	20.39	96.41	62.50
Harogem	2.30	15.60	5.00	1.60	0.08	44.20	68.78	11.46	135.21	88.43
Sabinovska 220	0.04	2.60	3.80	0.20	0.22	12.40	19.26	3.21	135.33	95.22
Lemeda (LE-962)	0.30	4.90	12.60	1.10	2.80	39.00	60.70	10.12	133.77	86.16
Lednická (M-90-A)	0.21	1.82	13.00	5.20	0.16	8.40	28.79	4.80	97.69	76.18
NJA-1	0.48	11.40	6.60	0.60	0.08	33.75	52.91	8.82	134.72	95.63
M-25	0.08	2.20	2.40	2.80	0.72	15.00	23.20	3.87	131.13	72.41
M-45	0.14	7.20	7.20	0.20	0.13	25.50	40.37	6.73	133.29	97.70
LE-SEO-24	2.20	5.50	9.80	0.50	1.50	34.70	54.20	9.03	131.61	84.50
LE-SEO-118	0.14	2.50	14.00	0.03	7.00	39.33	63.00	10.50	131.10	77.25
LE-390	0.08	15.60	5.20	16.00	3.02	53.60	93.50	15.58	115.73	82.25
LE-392	1.16	3.20	7.40	0.50	4.75	41.25	58.26	9.71	147.16	78.00
LE-1321	1.34	7.00	13.20	3.40	0.13	43.25	68.32	11.39	130.73	85.76
LE-1453	0.10	10.80	9.40	11.40	0.16	51.25	83.11	13.85	125.40	76.75
LE-1580	0.40	4.20	7.40	3.00	2.50	24.00	41.50	6.92	114.57	71.57
LE-1917	0.46	4.40	12.20	0.12	6.40	4.40	27.98	4.66	86.78	64.40
LE-2185	0.25	12.75	3.25	6.25	4.50	32.67	59.67	9.94	109.10	73.18
LE-2267	2.70	2.24	5.80	3.80	2.50	41.67	58.61	9.77	146.55	71.20
Average of yields (kg)	0.84	10.02	8.93	3.26	3.34	35.83	62.23	10.37	122.38	80.16
Coefficient of variation of yields (%)	132.6	89.4	45.9	123.4	129.5	42.7	×	×	×	×

*Control variety

Table 2. The rank of apricot genotypes according to average yield per tree over the period 1994–1999, expressed in % in relation to the control and in points according to the classifier for apricots

Rank	Genotype	Average yield 1994–1999		Points by the classifier**
		in kg/tree	in % in relation to control	
1	Sabinovska 220	3.21	59.44	2
2	M-25	3.87	71.60	3
3	LE-1917	4.66	86.36	5
4	Lednická (M-90-A)	4.80	88.86	5
5	Velkopavlovická LE-6/2*	5.40	100.00	6
6	M-45	6.73	124.58	9
7	LE-1580	6.92	128.09	9
8	Harlayne	7.10	131.54	9
9	NJA-1	8.82	163.29	9
10	LE-SEO-24	9.03	167.28	9
11	LE-392	9.71	179.81	9
12	LE-2267	9.77	180.88	9
13	LE-2185	9.94	184.16	9
14	Lemeda (LE-962)	10.12	187.35	9
15	LE-SEO-118	10.50	194.44	9
16	Sem. Bademerik	11.00	203.70	9
17	LE-1321	11.39	210.85	9
18	Harogem	11.46	212.28	9
19	LE-1453	13.85	256.51	9
20	Priusadebnyj	14.19	262.84	9
21	LE-390	15.58	288.58	9
22	Arzami aromatnyj	16.99	314.63	9
23	Volšebnyj	18.51	342.73	9
24	Vynoslivyj	20.39	377.59	9

* Control variety
** Points attributed according to the range given by the classifier for apricots:
less than 60% = 2 points, 100% = 6 points, more than 120% = 9 points (NITRANSKÝ 1992)

values and multiplied by a hundred. The difference in the values for a pair of years is always given with positive sign. The index of yield fluctuation was calculated according to the formula:

$$IF\% = \frac{(A1 - A2) + (A3 - A4) + (A5 - A6)}{A1 + A2 + A3 + A4 + A5 + A6} \cdot 100$$

where: *A* – production weight,
IF – index of fluctuation.

RESULTS AND DISCUSSION

Production weights of genotypes largely fluctuated over the six-year period. The maximum sum of yields over six years was recorded in Vynoslivyj variety (122.34 kg/tree) while the minimum sum was found in Sabinovska 220 variety (19.26 kg/tree). Average yield per tree in these varieties over six years amounted to 20.39 and 3.21 kg per tree, respectively (Table 1, Fig. 1). In comparison with control variety Velkopavlovická LE-6/2, the majority of genotypes was more productive and exceeded the control by more than 20%, which corresponds to 9 points according to the classifier (NITRANSKÝ 1992) (Table 2).

The responses of genotypes expressed by the level of yield to adverse conditions of some years over the evaluated period were not identical. It was evident from the proportions of genotypes in the classes defined on

Table 3. Correlations between the rank of apricot genotypes according to production weight per tree in the pairs of years in 1994–1999

	1994	1995	1996	1997	1998	1999
1994	1					
1995	–0.02	1				
1996	0.28	0.19	1			
1997	–0.26	0.32	–0.23	1		
1998	–0.16	**0.67**	0.31	0.06		
1999	0.23	**0.63**	0.17	**0.44**	**0.41**	1

In bold – the correlation is highly significant

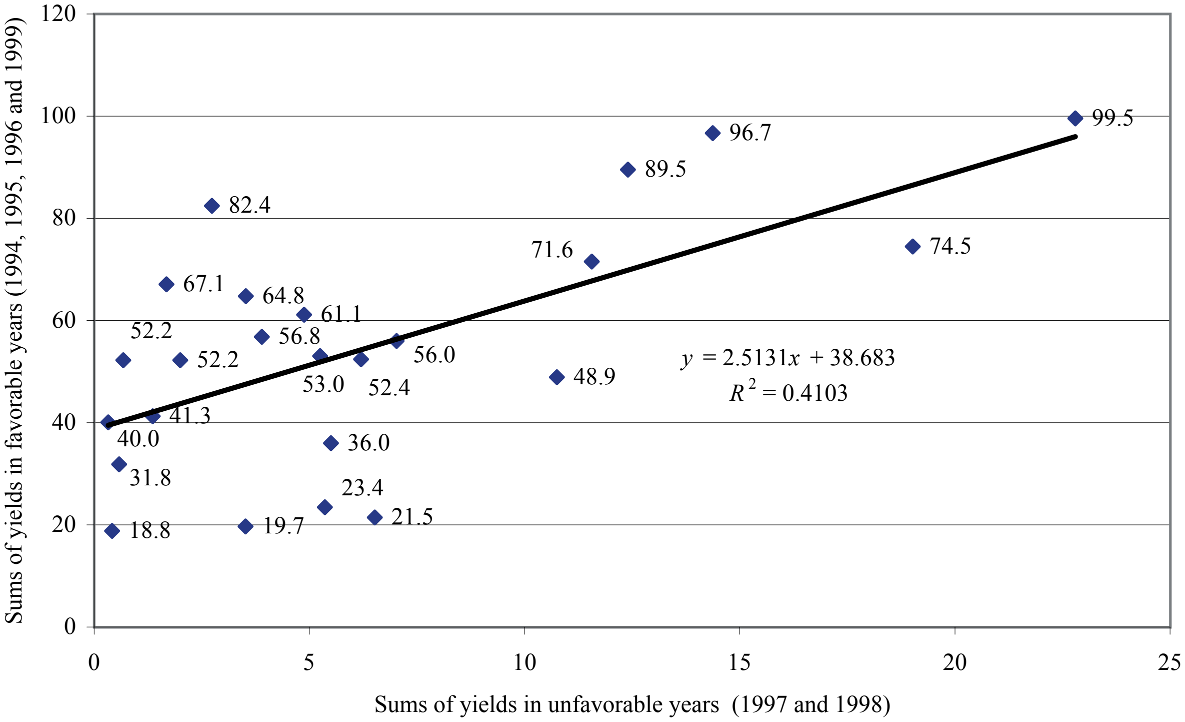

Fig. 2. Correlations between the sums of yields of apricot genotypes in years favorable and unfavorable for productivity ($r = 0.64^{++}$)

the basis of average production weight in kg per tree for the period with less favorable conditions for productivity. Twenty genotypes, i.e. 83.33%, with average yield higher than 8.59 kg per tree were classified as very productive in the year 1999, when the conditions for productivity were very favorable. An important finding is that genotypes with high productivity in the years favorable for productivity produced highest yields also in the years when the conditions for productivity were not favorable. It is proved by the highly significant

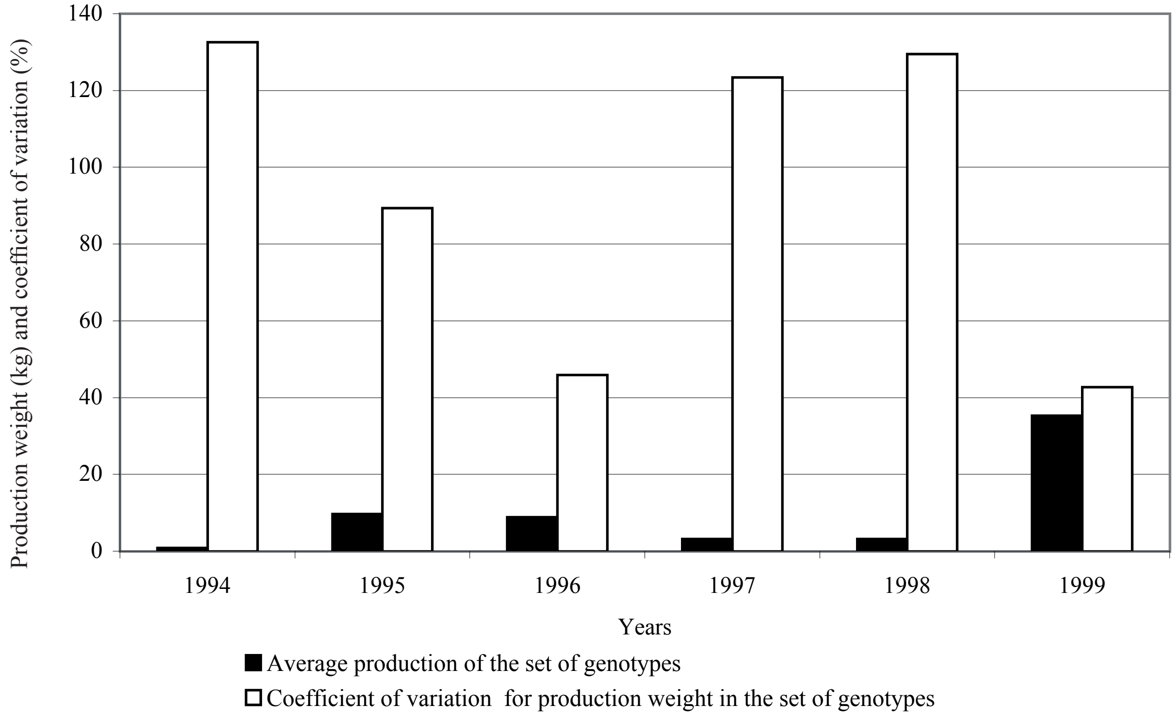

Fig. 3. Average production of apricot genotypes per year and coefficients of variation of production weight

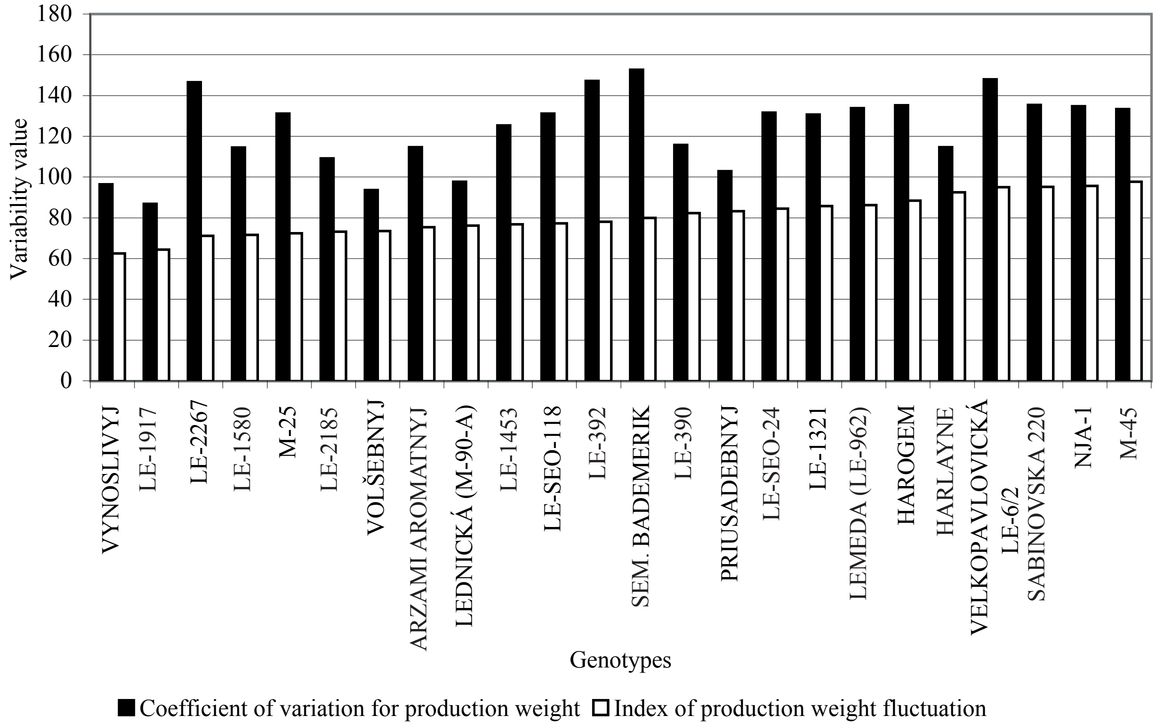

Fig. 4. Correlations between the indexes of production weight fluctuation and coefficients of variation for production weight in particular apricot genotypes in 1994–1999 ($r = 0.51^{+}$)

correlation coefficient $r = 0.64^{++}$ (Fig. 2). The correlation between the genotypes ranked in an ascending order according to productivity in the particular pairs of years is highly significant for some pairs of years. The correlation for the majority of the pairs of years is not significant. It can probably be explained by the heterogeneity of factors causing reduced productivity in some years (different susceptibility of genotypes to damage of floral

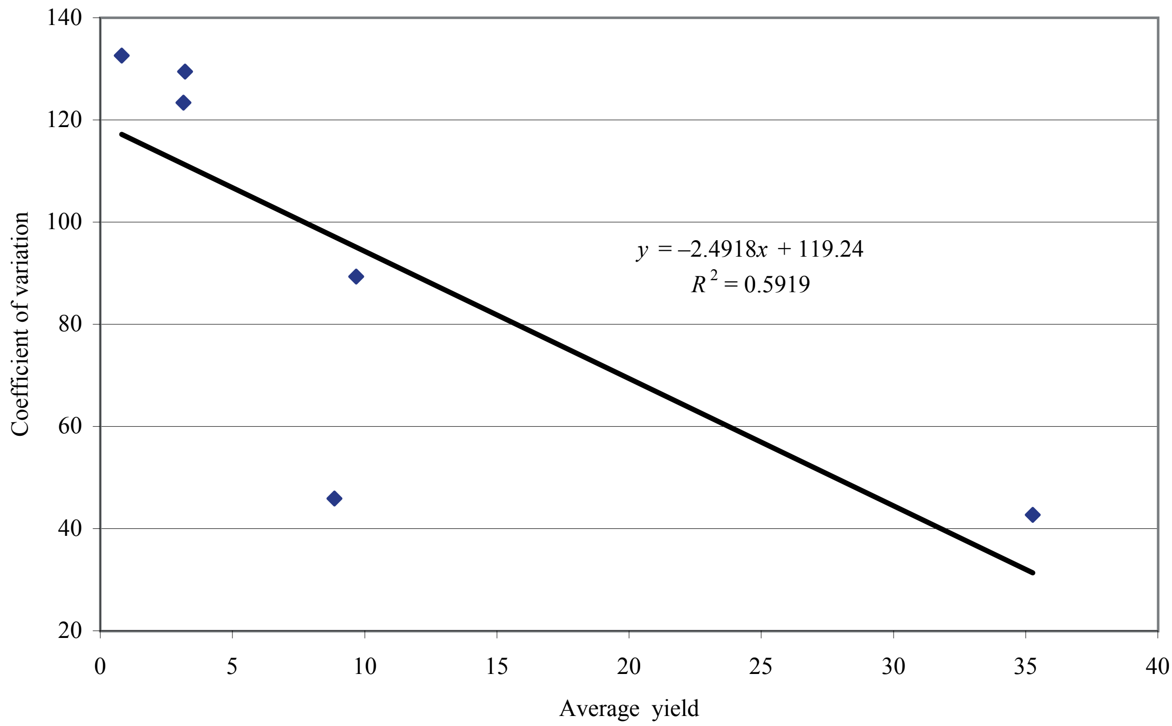

Fig. 5. Correlations between the average yield of the set of 24 apricot genotypes in particular years and coefficients of variation in these years ($r = –0.64$)

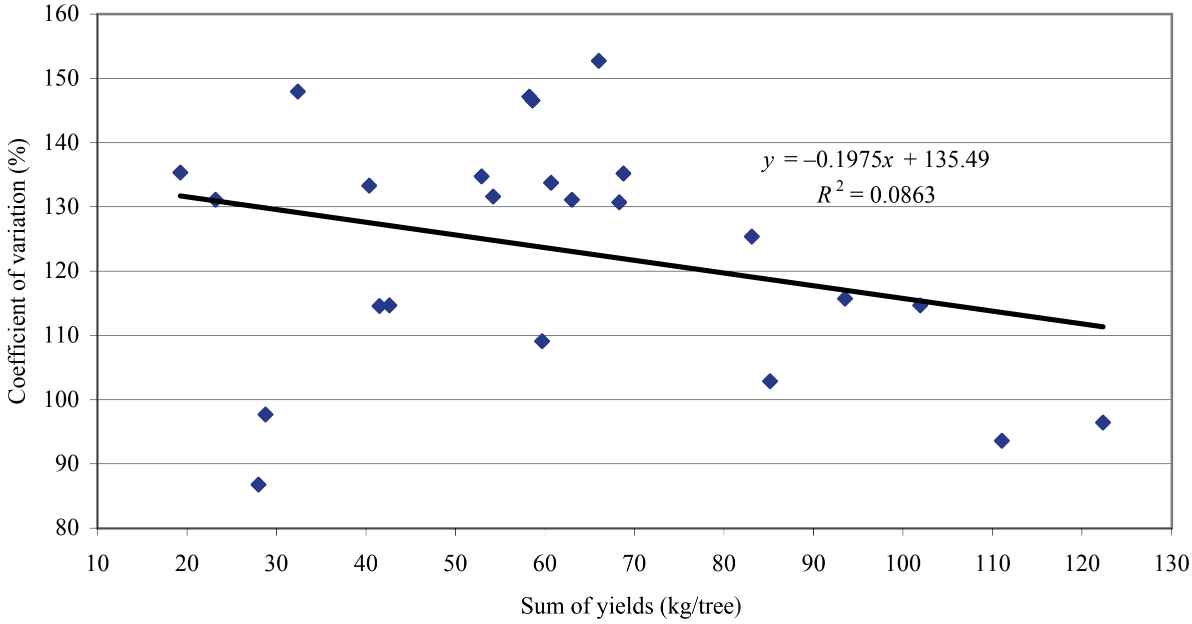

Fig. 6. Correlations between the sum of yields of particular apricot genotypes over six years and coefficients of variation for yields per tree in this period ($r = –0.29$)

buds, blooms, small fruits, different tolerance to cold and humidity at the time of pollen shedding and transfer, various microphenophases of blooming at the time of the action of harmful factors, etc.) – Table 3.

The variability of yields in kg per tree in particular years expressed by coefficients of variation was very high in general, but it was considerably lower in favorable years (that means with higher yields) than in unfavorable years except the year 1994. Higher variability in 1994 could be a result of the first commercially important production while the onset of productivity in the particular genotypes need not have been equally fast (Table 1, Fig. 3).

Fluctuations of yields in particular genotypes over six years were expressed by coefficients of variation and in-

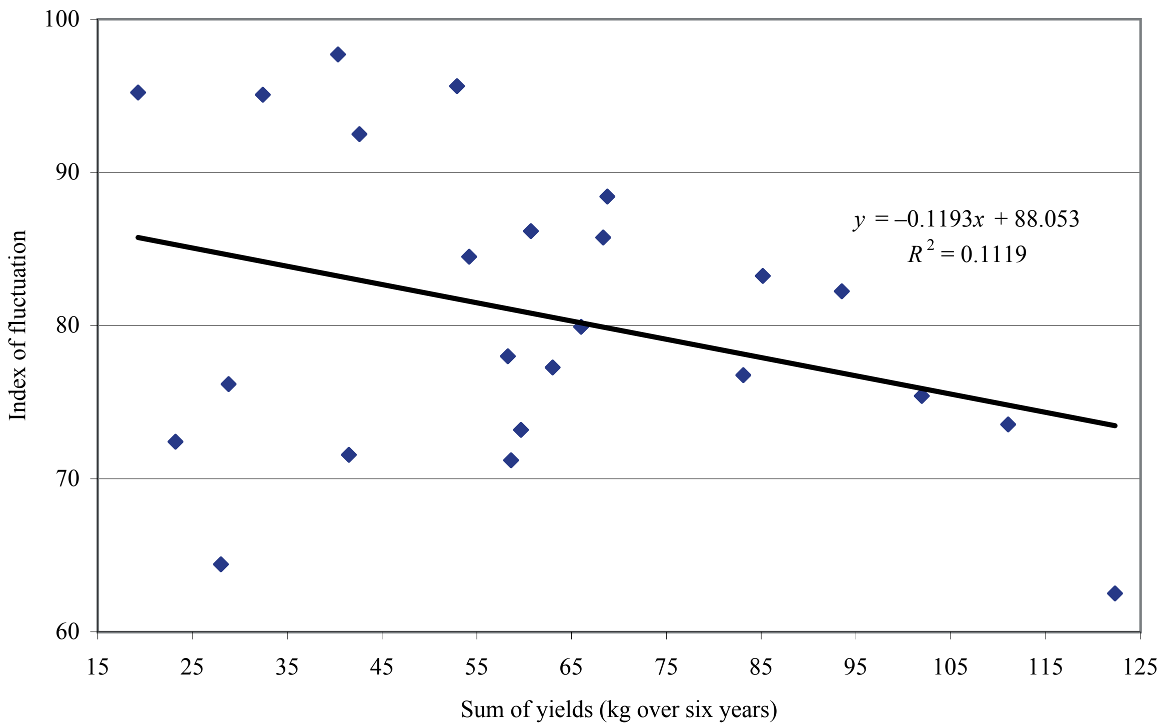

Fig. 7. Correlations between the sum of yields in kg over six years and index of yield fluctuation in apricot genotypes ($r = –0.33$)

dexes of yield fluctuation. To describe the variability of yields both methods of evaluation can be used because a positive significant correlation was found between the results of the calculation ($r = 0.51^{+}$) (Fig. 4).

An important, negative but insignificant close correlation ($r = –0.64$) was calculated between average yield of the set of 24 apricot genotypes in particular years and coefficients of variation for these years (Fig. 5).

There was an insignificant negative close correlation $r = –0.29$ between the sum of yields of particular genotypes over six years and coefficients of variation per tree over this period (Fig. 6). The evaluation of correlations between the sum of yields over six years and the index of production weight fluctuation gave a similar result ($r = –0.33$) (Fig. 7).

The control variety Velkopavlovická was evaluated over the period of six years as a less productive and little stable genotype. Vynoslivyj and Volšebnyj were the varieties with highest productivity and yield stability. Of them, Vynoslivyj variety is most remarkable from the producer's and breeder's aspects by its quality of fruits and late ripening.

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Hmotnost sklizně a její variabilita u 24 genotypů meruněk v období šesti let

ABSTRAKT: V šestiletém období od roku 1994 do roku 1999 byla hodnocena u 24 genotypů meruněk plodnost a její stabilita. Většina genotypů byla plodnější než kontrolní odrůda Velkopavlovická LE-6/2. Genotypy s vyšší plodností v letech příznivých pro plodnost meruněk byly nejplodnější i v letech pro plodnost nepříznivých. Bylo to prokázáno význačnou vysoce průkaznou těsností závislosti ($r = 0{,}64^{++}$). To zdůvodňuje nutnost regulovat u nejplodnějších odrůd násadu plodů v letech příznivých pro plodnost meruněk. Variabilita sklizní v kg na strom vyjádřená variačními koeficienty byla ve sledovaném období obecně vysoká. Výrazně nižší variabilita sklizní byla v letech příznivých pro plodnost meruněk, kdy dochází k přeplozování a k nežádoucímu zmenšení plodů. Pro vyjádření variability sklizní jsou použitelné jak variační koeficient, tak i index kolísání. Jejich podobnou vypovídací schopnost prokázala význačná průkazná kladná těsnost závislosti mezi hodnotami získanými oběma výpočty ($r = 0{,}51^{+}$). Mezi nejplodnější a nejstabilněji plodící patřily odrůdy Vynoslivyj a Volšebnyj. Z nich Vynoslivyj i kvalitou plodů a pozdním zráním patří k pěstitelsky a šlechtitelsky nejpozoruhodnějším genotypům.

Klíčová slova: meruňka; genotypy; hmotnost a stabilita plodnosti; variabilita individuálních sklizní; variační koeficient; index kolísání sklizní; vztahy mezi roky

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