THE MORPHOLOGICAL DIVERSITY OF SELECTED TRAITS OF WORLD COLLECTION OF POPPY GENOTYPES (GENUS PAPAVER)

MORFOLOGICKÁ DIVERZITA VYBRANÝCH VLASTNOSTÍ SVETOVEJ KOLEKCIE MAKU (ROD PAPAVER)

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ABSTRACT

In the first stage of research the 404 genotypes of poppy (Papaver) from World collection were evaluated during 1999. The field trial was established on research base of SAU in Nitra. The aim of the study was to assess morphological characteristic and diversity of selected traits of poppy plants and create a digitalized visual documentation of studied traits of collection. 50-60 individuals for each accession were cultivated. During vegetation period 22 morphological traits have been assess and visual documentation of main flower, lower leaf, capsules and seed was made. During the phase of mature, 20 randomly selected plants were analyzed for 24 qualitative and quantitative traits. On the base of screening follow-up assessment of 94 genotypes was broadening of 8 morphometric analysis of plant during 2003. In present work variability of evaluated traits and morphometric analysis of 24 selected genotypes of poppy is discussed. On the base of morphometric analysis, the important diversity of observed traits have been recognized in agro-climatic conditions of Slovakia, documented by statistical characteristics and by digitalized documentation of accessions.

KEY WORDS: descriptor list, diversity, poppy, morphometry, world collection

PODROBNÝ SÚHRN

Rod Papaver s počtom 70 druhov je najväčší s čeľade Papaveraceae. Papaver somniferum patrí do čeľade Mecones [5]. Mak patrí medzi najstaršie domestikované a pestované olejniny na Slovensku. Cieľom štúdie bolo vyhodnotiť morfologické vlastnosti a diverzitu vybraných vlastností rastlín maku v našich agroklimatických podmienkach a spracovanie digitálnej dokumentácie študovaných vlastností 404 genetických zdrojov získanej kolekcie s Inštitútu VIR N.I. Vavilova v St. Petersburgu [2].V roku 1999 bolo počas vegetácie hodnotených 22 morfologických znakov a vo fáze zrelosti bola pri 20 rastlinách hodnotená hmotnosť nadzemnej časti rastliny, výška rastliny, rozpätie vo výške nasadenia toboliek, hmotnosť toboliek, hmotnosť semena jednej tobolky, hmotnosť tisíc semien. Na hlavnej tobolke sa hodnotilo postavenie podpornej kvetnej stopky, rebrovanie, tvar tobolky, pukanie tobolky pod bliznou, tvar blizny, šírka blizny, šírka tobolky, dĺžka tobolky, index tobolky, šírka plodolistov, dĺžka plodolistov, a farba semena. Pre ďalšie hodnotenie bolo vybratých 94 genotypov, ktoré sa hodnotili v roku 2003. Pozorovania boli rozšírené o morfometrické merania rastlín a štatistické vyhodnotenie znakov: výška rastliny, počet toboliek na rastlinu, rozpätie vo výške nasadenia toboliek, hmotnosť semena jednej tobolky, hmotnosť makoviny jednej tobolky, HTS, počet lalokov blizny, index tobolky (tab.3). Prejav znakov bol hodnotený podľa inovovaného zoznamu znakov z medzinárodného klasifikátora UPOV, znaky ktoré nie sú uvedené v medzinárodnom klasifikátori, boli doplnené z českého klasifikátora [8]. Výberový súbor 24 genotypov (tab. 4) je charakterizovaný 8 štatistickými hodnotami uvedenými v tab. 3. Podľa klasifikátora možno genotypy charakterizovať ako nízke až stredne vysoké. Výška rastliny je geneticky podmienená avšak podmienky prostredia môžu ovplyvniť manifestáciu prejavu. Nižšie rastliny 0,7-0,75m sú vhodnejšie pre ideotyp univerzálneho maku kvôli menšiemu riziku poliehania a vyvrátenia (tab. 3, 4). Pri spone 0,25x0,1m mali genotypy v priemere 2,05 makovíc na rastlinu s nízkym variačným koeficientom 25,4%. Rozpätie vo výške nasadenia najvyššej a najnižšej tobolky je znak určujúci pestovateľskú vyrovnanosť porastu maku, bola zistená najvyššou variabilitou tohoto znaku 38,08% s hodnotami 0,027m - 0,134m. Pre ideotyp maku je požiadavka na rozpätie 0,06m [18]. Priemerná hmotnosť semena jednej tobolky bola 1,77g, šľachtiteľský cieľ pre modro semenné maky je 3,2-3,5g. Počet lalokov na blizne tobolky zodpovedá počtu lamiel vo vnútri tobolky, na ktorých sa vytvára semeno, hodnotený znak mal najnižšiu variabilitu. Index pomeru dĺžky a šírky tobolky indikuje tvar tobolky. Najväčší index 1,46 dosiahol genotyp Papaver Mephisto s najväčším počtom bliznových lalokov. Šírka a dĺžka plodolistov podmieňuje ich plochu a následne využitie plochy lamiel na tvorbu semena. Je žiaduce aby lamely zasahovali čo najviac do vnútorného priestoru tobolky, čomu najlepšie vyhovuje guľovitý tvar tobolky. Šírka plodolistov bola v intervale 1,8-4,6 mm, dĺžka plodolistov 15,25-27,93 mm. Priemerná váha makoviny jednej tobolky výberového súboru bola 1g. Šľachtiteľským cieľom pre konzumný mak je modré, farebne vyrovnané semeno. Genotypy č, 6, 7, 8, 19 a 22 mali sivé semená. Tento znak je v kladnej korelácii s obsahom alkaloidov v makovine [16,19]. Na základe morfometrickej analýzy boli zistené významné rozdiely sledovaných znakov genotypov maku v agroklimatických podmienkach Slovenska doložených štatistickými parametrami vybraných genotypov a databázou a obrazovou dokumentáciu 404 genotypov pre ďalšie využitie.

INTRODUCTION

The Poppy Family Papaveraceae is divided into four subfamilies based upon critical details of the floral morphology and fruit characteristics. The subfamily Papaveroideae is the largest subfamily with nine genera and probably in excess of 150 species. The genus Papaver, largest in the poppy family, contains some 70 species scattered primary across hemisphere from sea level to the high mountains. The species can be annuals, biennials or perennials (with leafy stems or, alternatively, all the leaves may be basal). The species of Papaver divide conveniently into 8 of sections. Papaver somniferum belongs to the section Mecones [5]. The most frequently cultivated are the oriental poppy Papaver pseudoorientale (FEDDE.) MEDW., usually bearing a large scarlet flower with a purplish black base, and the corn poppy Papaver rhoeas and its variety, the Shirley poppy. Other well-known species include the arctic Iceland poppy Papaver nudicaule [7].

The poppy is widely distributed all over the world, in very different soil and climate conditions, from equatorial countries to India, middle Europe and south areas of Scandinavia and Great Britain. The leaders in seed poppy production (Papaver somniferum L.) for nutrition purposes are Czech Republic and Turkey, biggest producer of opium poppy is Afghanistan and Tasmania growing poppy for medicinal opiate. Poppy is important ingredient of traditional food in some European countries [15]. Seed poppy belongs to the oldest domesticated and cultivated oil-plants in Slovakia. Based on this fact, there are needed repeatedly to monitor and collect and evaluate the samples for qualitative and quantitative traits.

Attention focus mainly on the traits variability of seeds, capsules, flowers and leaves [10]. The poppy flower has four kinds of organs arranged in concentric whorls, two sepals in two outermost whorls, four petals arranged in two whorls, inner to sepals, several whorls of stamens and a gynoecium comprising many fused carpels. The gynoecium has a stigmatic plate, a very short style and an ovary. Each carpel of syncarpous unilocular ovary on the inside bears a placenta, the two sides of which bear the ovules. The ovary (capsule) wall has a vast network of laticiferous vessels which are the principle site of synthesis and accumulation of alkaloids [7]. In Slovakia 1103 accessions of poppy collection (including duplication) is maintenance in Institute of Protection of Biodiversity and Biological Safety, Slovak University of Agriculture in Nitra. New accessions are acquire from collecting expeditions in traditional regions in Slovakia, and accessions obtained from institutions focused on research and conservation of poppy abroad and in Slovakia. The biggest collection is from the N.I. Vavilov Institute of Plant Industry, as a keeper of one of the world's largest collections of plant genetic material, and 404 accessions of poppy from Institute were obtained in 1999 [2]. The research of gene pool of poppy in Slovakia was carrying out also in frame of project "Preservation and Conservation of the gene pool of old and land races of Slovak plant species" [3]. Work with genetic resources of poppy is made more difficult by the limited access to information that causes opium and its abuse as a drug.

Veselovskaja [19] on the base of study of changes of morphological and ecological features of big collection of poppy in different climatic types compiled ecological-geographical classification of species. There are characterized subspecies from the point of oiliness and alkaloid content. It is pointed out that in one cultivar it is possible to match high oiliness of seeds with high content of alkaloids in capsules.

For morphological, phenological and qualitative evaluation it was developed "Universal classificator of poppy" [8]. In 1997, the Research Station in Malý Šariš evaluated the collection of 138 varieties of European origin in which was covered with writing 37 morphological and qualitative and quantitative economic characteristics between 1994-1996 [13].

The aim of the study was to assess morphological characteristic and diversity of selected traits of poppy plants in our agro-climatic conditions and create a digitalized visual documentation of studied traits of collection.

MATERIAL AND METHODS

In the first stage of research the 404 genotypes of poppy (Papaver) from World collection of VIR N.I. Vavilov in Petersburg were evaluated during 1999. The field trial was established on research base of Department of Genetics and Plant Breeding on SAU in Nitra.

Each genotype (accession) was sown in three rows at 0.1 m intra-row and 0.25 m inter-row spacing to be cultivated 50-60 individuals for each accession. During vegetation was evaluated 22 morphological traits (listed in Table 1) and was made visual documentation of main flower and lower leaf in stage of prolongation of stem that was supplemented of visual records of capsules and seeds (Figure 1).

During the phase of mature was randomly selected and in laboratorial conditions analysed 20 plants of each genotype. All evaluated traits of the plants are written in Table 2.

On the base of screening was further evaluation of

Table 1. Traits evaluated during vegetation (genus *Papaver*)
Tabuľka 1. Hodnotené vlastnosti počas vegetačného obdobia (rod *Papaver*)

Part of plant	Trait
Hypocotyl	anthocyanin coloration
Rosette leaf	diameter, colour, hairiness
Stem leaf	position to stem, colour, waxiness, shape of leaf blade, shape of margin of leaf blade, type of incisions of margin
Main bud	colour, shape, hairiness
Main flower	type of flower, colour of petal, type of petal, type of incisions, colour of bloch, intensity of colour of bloch, type of bloch, dimension of bloch, color of stamen filaments

Table 2. Traits evaluated in laboratory (genus *Papaver*)
Tabuľka 2. Hodnotené vlastnosti v laboratóriu (rod *Papaver*)

Part of plant	Traits
Plant	weight of plant, height of plant, range of highness of capsules, number of capsules, weight of capsules with seed, seed weight of one capsule, thousand seeds weight
Main capsule	shape of base, ribbing, shape, dehiscens, stigmatic disc shape, shape of stigmatic disk midpoint, surface of stigmatic disc lobes, apex of stigmatic disc lobes, number of stigmatic disc lobes, stigmatic disc width, capsule width, capsule length, index of capsule, width of seed lobe, length of seed lobe, seed colour

selected 94 accessions that were sown in 2003. The experimental site belongs to warm and moderate arid climatic region in the south-west of Slovakia. The long term average precipitation is 561 mm, for the growing season 327 mm with average air temperature is 9.7°C. The year 2003 was characterized by very dry February (0.7 mm), March (2.3 mm), June (6.5 mm) and wet July (92 mm) with an average temperature 10.8 °C in the experimental site. The organization of trial was identical with the year 1999. Totally 65 plants in average were grown for each genotype. Observations were broaden of morphometric analysis of traits of plant - together 6 traits listed in Table 3 besides thousand seeds weight and index of capsule. We have analyzed more detailed the selected set of 24 genotypes listed in Table 4. Genotypes origin is from Germany (9), from France (5) from England (2) and from India, Kazakhstan, Mongolia, Persia, Afghanistan, Turkey, Altai and Samarcand region for one.

On each genotype we have evaluated manifestation of 22 morphological characteristics on cotyledon, leaves, buds and flowers (Table 1). Demonstration of features was evaluated according innovated descriptors list from international descriptor (UPOV, 1999) and for features which the classificator did not contain (hypocotyl anthocyanin coloration, leaf colour, leaf shape, leaf shape of margin, leaf type of incisions of margin, bud colour, bud shape, bud hairiness, type of petal, dimension of bloch) we have used classificator developed in Czech Academy of Science with collaboration with Research Institute of Crop Production Prague Ruzyňe and with the Research Station of Oil crops in Opava [8] and descriptors of traits used at the Research Breading Station in Malý Šariš (leaf position to stem, leaf waxiness, type of flower).

During flowering phase, 10 flowers from each genotype were isolated to prevent facultative pollination. Twenty plants from each genotype were collected for laboratory analysis in full maturity stage. 24 qualitative and quantitative traits of whole plant and main capsule have been evaluated (Table 2). For each genotype we have calculated the main statistical values, simultaneously the statistical indicators have been calculated for individual traits and for complete selected set of genotypes by SAS software. Digital visual database of leaves, flowers, the main capsule and seeds have been made from the set of 404 accessories. Seed material from analyzed plants is maintaining at Institute of Protection of Biodiversity and Biological Safety.

RESULTS AND DISCUSSION

Selected collection of 24 genotypes of poppy is characterized with basic statistical values of 8 features in Table 3. Tested genotypes have extended the height of 1.05 meters in our conditions. Minimal value was measured at accession No 13 Papaver pilosum L. (0.65 m) and maximal value at genotype No 24 Mak želtyj Choš-Choš-Sary from Turkey (1.39 m). Genotype with lowest height reached only half of the height of highest genotype. 12 genotypes exceeded an average value of the set with its height. Genotypes can be selected between low to middle high on the base of the descriptor. The height of a plant is a trait of a cultivar but cultivating conditions influence its appearance. Miklošíková et al. [11] evaluating the collection of 55 old species and landraces of Slovak origin documented range of plant height 1.102-1.514 m. Lower plants 0.70-0.75 m are more useful for the ideotyp of universal poppy where is lower risk of uprooting and lodging (Table 3, 4).

In the using plant organisation (0.25 x 0.1m) genotypes have made in average 2.05 capsules at one plant. Small range between minimal (1.45) and maximal (2.94) value of this trait is characterized by coefficient of variation 25.4%. The lowest numbers of capsules have made the genotype with the smallest height No13 Papaver pilosum. The most capsules created No 8 from Samarcand region which has reached the biggest seed weight from a plant. Under dense planting conditions of cultivation, individual Papaver somniferum poppy plants produce 1-3

Table 3. The main statistical characteristics of selected traits of select set of poppy (genus *Papaver*)
Tabuľka 3. Hlavné štatistické ukazovateľe vybraných vlastností výberového súboru maku (genus *Papaver*)

Statistics	Height of plant (m)	Numbero f capsules of one plant	Span of capsules (mm)	Seed weight of one capsule (g)	Weight of poppy capsule (g)	Thousand seeds weight (g)	Number of lobes of stigma	Index of capsule
Minimum	0.65	1.45	27	0.74	0.55	0.313	10.08	0.99
Maximum	1.39	2.94	134	3.26	1.58	0.555	12.93	1.46
Coefficient of variation	25.42	18.88	38.08	34.83	28.92	13.56	6.27	10.19
Mean value	1.05	2.05	73	1.77	1.00	0.435	11.42	1.19

capsules from equal number of flowers [14]. The number of capsules on a plant is a genetically conditioned trait but greatly influences by the number of plants and area unit but also nutrition cover. The bigger number of less branched plants also with smaller yield of seed from a plant offers higher harvest on the area unit. The regular placement of plants in square organization of plant is important with minimal branch and they have 1.2-1.6 capsules on a plant. In this case capsules have matured regularly [4]. Up to 22 genotypes have reached bigger number of capsules on a plant in evaluated set (Table 3, 4).

Span of capsules (the range of height of placement of the highest and lowest capsule) is very important feature from the point of cultivated uniformity of poppy plants. Evaluated collection reached high variability in interval from 27 mm (genotype No 21 Poppy opijnyj/P from Persia) to 134 mm (genotype No 22 Poppy opijnyj/A from Altaj) in agro-climatic conditions during 2003. High variability of evaluated trait has appeared by highest coefficient of variation 38.08%. Measured values of its trait can be classified between small to medium according classificator. The request of the range 60 mm is on poppy plant at ideotyp traits [18]. 14 genotypes in our collection with their average value exceeded desired value for ideotyp.

The seed weight of one capsule with the number of capsule on one plant and number of plants at area unit belong between main production traits of poppy. Genotype No 13 Papaver pilosum has reached again the minimal value of the trait 0.74 g and maximal value 3.26 g genotype No 22 Mak opijnyj/A from Altaj with the lowest uniformity of stand. The average value of the whole collection was 1.77 g. The half of genotypes exceeded the value together with the average height of collection. Breeding aim of universal blue seed poppy requires value 3.2-3.5 g [4]. In evaluated collection the level has been reached only by one genotype- Mak opijnyj No 22 (Table 3). Miklošíková and Tóth [9] by evaluating variability of economic traits of old varieties and landraces of opium poppy in Slovakia received in average 4.1 g of seeds from one capsule.

Analyzed genotypes according weight of thousand seeds were classified as small seeds group with TSW up to 0.46 g and medium seeds group with TSW in interval 0.46-0.65 g, with low coefficient of variation of selective collection (13.56). None of evaluated genotypes has reached breeding aim TSW 0.80 g.

Number of stigmatic disc lobes is connected to the number of seed lobes inside the capsule where the seed is made. Assessed genotypes set up 11.42 lobes in average on a capsule. The highest number has been recognized at genotype No 19 Papaver Mephisto 12.93 and the smallest number at genotype No 4 Pavot 99 a fleur frangee violet heliotrope 10.08. The assessed trait has had the lowest coefficient of variation 6.27 that refers to very low variability trait of assessed genotypes. According classificator, genotypes can be categorized into types with the middle number of lobes from 8-15. Within species the number of lobes is from 5-24. From the point of seed harvest from one capsule the optimal number is 14-16 lobes on one capsule [4]. Difference in size can be deduced from the height and width of capsule. The width of capsules was in interval 17.60 - 30.70 mm and the length of capsule in interval 23.23 - 37.30 mm. The average value of evaluated collection in the length of capsule 28.20 mm has exceeded 9 genotypes. Evaluated genotypes set up small capsules. The ideotyp requires capsules 50-55 mm long. Requires level did not achieve any genotype in evaluated set (Table 4).

The index of capsule is a number ratio between the length and width of a capsule that indicates the shape of the capsule. Capsules of globular shape reach the index close to 1.0. In evaluated collection 23 genotypes have been recorded with the index value 1.0 and low value of coefficient of variation 10.19. The highest index 1.46 has reached genotype Papaver Mephisto with the biggest number of lobes. The shape of the capsule characterized by the index is a typical cultivar trait. It is very unbalanced in

Fig. 1 Example of main flower, capsules and seeds diversity of evaluated collection of poppy plants.
Obrázok 1. Príklad diverzity hlavného kvetu, tobolky a semien hodnotenej kolekcie rastlín maku.

genotypes with higher number of capsules that gradually mature. The breeding aim is a cultivar with capsules of globular shape in which is set up the biggest share of big seeds [1]. The evaluated collection is characterized by dominance of globular but smaller capsules.

The width and length of seed lobes qualifies their surface and subsequently utilization surface of lamellas to seed formation. It requires lamellas to reach as much as possible the inner space of the capsule. The requirement is meet most when capsules are globular shaped. In our collection genotype No 20 has had the widest seed lobes 4.60 mm and genotype No 5 the narrowest ones 1.80 mm. Genotype No 3 Papaver somniferum flore pleno has had the longest seed lobes (27.93 mm) and genotype No 1 from England has had the lowest value (15.25 mm). It has been found out the lowest value of capsule index of genotype with the widest seed lobes. Using of lobes surface to 80-85% indicates better utilization of space of capsule. Unused surface is at the ends of narrowing seed lobes on both poles of the capsule and their portion on the surface of seed lobe is bigger with the growing length of the capsule. The enlargement of carpel wall volume where alkaloids are accumulated, also increase the yields of alkaloids. Isolation of recessive aco (androcarpel organ) mutation in opium poppy Papaver somniferum is expected to generate improved genotypes of opium poppy for the production of alkaloid rich carpel straw raw material [14].

The weight of poppy capsule without seed is the trait which value with alkaloids mainly morphine during the large farming of poppy is the important indicator of morphine harvest of dry poppy [16]. During the plant

Table 4. The average value of selected traits on the plant and main capsule of selected set of poppy (genus *Papaver*)
Tabuľka 4. Priemerné hodnoty vybraných vlastností rastliny a hlavnej tobolky výberového súboru maku (genus *Papaver*)

No	genotype	Country of origin	Weight of plant (g)	Height of plant (m)	Span of capsules (mm)	Number of capsules	Seed weight of plant (g)	Seed weight of capsule (g)	Weight of poppy capsule (g)
1	Poppy,Shirley, Sutton's Double Salmon	England	8.13	0.77	37	1.75	2.44	1.40	0.82
2	Poppy,Shirley, Sutton's Double Mixed	England	8.59	0.81	47	1.50	2.30	1.53	1.11
3	Papaver somniferum flore pleno	France	14.96	1.29	75	2.00	3.68	1.84	1.20
4	Pavot 99 a fleur frangee violet heliotrope	France	16.04	1.11	77	2.00	4.92	2.46	1.32
5	Pavot 99 a fleur fragee rose vif	France	9.85	0.90	41	1.82	3.20	1.76	0.82
6	Pavot simple blac borde ecarlate Amiral	France	16.53	1.31	87	1.67	4.70	2.82	1.55
7	Pavot d'Orient vivace varie	France	7.41	0.75	74	191	2.49	1.30	0.68
8	Mak /S	Samark.reg.	21.04	1.36	102	2.94	6.30	2.14	1.20
9	Mak /I	India	7.74	0.75	63	2.13	191	0.90	0.73
10	Mak /K	Kazakhstan	5.77	0.74	54	1.96	1.86	0.95	0.55
11	Mak opijnyj /M	Mongolia	6.68	0.74	35	1.92	1.83	0.95	0.83
12	*Papaver rhoeas*	Germany	7.22	0.81	57	1.82	2.00	1.10	0.71
13	*Papaver pilosum*	Germany	3.96	0.65	41	1.45	108	0.74	0.55
14	*Papaver som*. nanum fl.pl.cardinale hegelb	Germany	19.45	1.35	112	2.79	6.03	2.16	1.05
15	*Papaver somniferum*	Germany	21.69	1.35	95	2.60	5.57	2.14	1.33
16	*Papaver som*. laciniatum fl.pl.gemischt	Germany	18.11	1.32	88	2.41	4.59	1.90	1.17
17	*Papaver alpinum*	Germany	19.08	1.37	107	270	5.62	2.07	1.09
18	*Papaver nudicaule*	Germany	8.83	0.89	53	1.80	276	1.54	0.75
19	Papaver Mephisto	Germany	9.68	0.80	54	2.21	3.29	1.49	0.77
20	*Papaver somniferum* Virginia	Germany	13.62	1.10	98	2.13	4.03	1.90	0.94
21	Mak opijnyj /P	Persia	11.33	0.92	27	196	3.40	1.74	0.93
22	Mak opijnyj /A	Altai	18.63	1.29	134	1.80	588	3.26	1.58
23	Choš-Choš	Afghanistan	16.29	1.35	90	2.30	4.38	1.90	1.02
24	Mak želtyj Choš-Choš-Sary	Turkey	18.14	1.39	97	1.71	4.35	2.55	1.36

Table 4. continue

No	Thousand of seeds weight (g)	Number of lobes of stigma	Width of capsule (mm)	Length of capsule (mm)	Width of seed lobe (mm)	Length of seed lobe (mm)	Index of capsule	Seed colour	Petal colour
1	0.471	11.53	24.80	26.53	3.33	15.25	1.07	brown	violet-grey
2	0.555	10.93	22.40	29.07	2.73	15.60	1.30	black	white
3	0.380	11.53	22.60	30.67	2.47	27.93	1.36	tawny (sienna)	vine-red
4	0.313	10.08	19.62	23.23	2.23	21.08	1.18	brown	violet
5	0470	10.90	21.30	23.60	1.80	21.40	1.11	black	violet
6	0.442	11.07	24.93	29.93	2.93	27.00	1.20	grey	white
7	0.462	10.20	22.87	27.73	2.27	25.93	1.21	grey	white
8	0.372	12.00	24.00	27.00	2.43	24.71	1.13	grey	white
9	0343	11.57	23.21	27.86	3.14	25.00	1.20	white	vine-red
10	0.421	12.07	25.60	30.27	3.33	27.73	1.18	tawny (sienna)	vine-red
11	0.409	12.33	27.27	30.00	3.47	27.20	1.10	pink	violet
12	0.367	11.10	21.90	24.30	2.80	22.70	1.11	powder blue	white
13	0.353	11.47	24.27	27.13	2.93	24.87	1.12	blue	pink
14	0.421	11.53	21.80	23.33	3.27	21.87	1.07	brown	carmine-red
15	0.355	11.08	20.25	23.83	2.00	21.58	1.18	olivaceous	white
16	0.468	11.54	21.00	26.46	2.38	24.31	1.26	black	pink
17	0.472	11.53	26.20	26.60	2.80	24.40	1.02	black	white
18	0.429	10.53	25.20	28.00	3.87	25.80	1.11	brown	white
19	0.448	12.93	17.60	25.73	4.00	23.67	1.46	grey	white
20	0.437	12.50	30.70	30.50	4.60	21.50	0.99	olivaceous	white
21	0.493	11.25	27.08	36.33	3.50	27.08	1.34	black	red
22	0.499	11.14	25.29	27.86	3.71	17.71	1.10	grey	white
23	0.499	12.60	28.40	37.30	4.00	27.00	1.31	black	carmine-red
24	0.470	10.56	23.67	33.56	2.78	25.67	1.42	black	violet

mature the content of alkaloids is more concentrated into the walls of capsules and in the process of full mature capsules contains about 90% from the whole amount of alkaloids in a plant. In our collection genotypes have reached the average weight of poppy capsule 1.00 g and eleven genotypes have reached higher poppy capsule weight than the average weight. In genotype No 22 Mak opijnyj/A from Altaj with the maximum weight of poppy capsule 1.58 g also the highest seed weight in a capsule (3.26 g) has been found out. Genotype No 10 Mak/K from Kazachstan has reached the minimal value. The ideal type of universal blue seed poppy is set up the value trait 2.5 g. None of the valued genotypes has reached this level (Tables 3, 4).

In valued collection has been recorded one white seed, 1 pink seed, 2 blue seed genotypes, 2 with tawny (siena) seed, 2 olivaceous seeds, 4 brown seeds, 5 with grey seeds, and 7 black seed genotypes. The seed colour of variety is genetically determined. In the set of assessed genotypes we have recognized 5 genotypes (No. 6, 7, 8, 19 and 22) with the grey seed. The trait is in positive correlation with the content of alkaloids in poppy [16, 19] and offers the further and deeper study of mentioned genotypes (Table4). The aim of breeding of consumer poppy is blue balanced seed. Havel [6] by evaluation of 167 genotypes of opium poppy collection ascertained that only Czech and Czechoslovak varieties have a nice blue seed colour. Seeds of other poppy accessions are mainly grey. One of the characteristic variety traits is the colour of flower petals. In observed set there have been 11 genotypes with white petals, 4 violet, 3 vine red, 2 pink, 2 carmine red and 1 carmine-red and violet-grey (Table 4). In evaluated set there have been assessed also 4 genotypes declared as Papaver rhoeas (No 12), Papaver pilosum (No 13), Papaver alpinum (No 17), and Papaver nudicaule (No 18). Traits of these genotypes were compared with evaluation of Novák and Preininger [12], who revised taxonomic classification of the genus Papaver on the morphologic base, morphologic-geographic, karyologic, phyto-chemical and anatomic study with regard to real conditions of individual sections. The levels of several traits that have been found out, do not relate with the features of these poppy forms. The genotypes require deeper and longer study in chemical structure mainly the content of alkaloids that would be helpful in identification.

In assessed set on the base of morphometric analysis the important diversity of observed traits have been recognized in agro-climatic conditions of Slovakia documented by statistical characteristics and by digitalized documentation for further usage.

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