

**ORNAMENTAL FEATURES OF COLLECTION SAMPLES OF THE  
SPECIES CALENDULA L. OF THE RESEARCH STATION OF  
MEDICINAL PLANTS**

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***Purpose.** To select the source material for creation of pot marigolds ornamental varieties. **Methods.** Field, laboratory, mathematical and statistical. **Results.** The characteristic of marigolds gene pool samples is given for ornamental and agronomical characteristics under which their integrated assessment was carried out. **Conclusion.** The collection samples are distributed by thirteen attributes. Promising ornamental varieties are highlighted: Chernoe serdtsce, Zen Orange, Indian prince and Mandarin Twist.*

*Keywords: pot marigold, collection, sample, feature, ornamentality.*

**Introduction.** The pot marigolds (*Calendula officinalis* L.) is one of the large crops that have multilateral use worldwide. Their raw materials (inflorescence, root, stem and leaves) are used in the chemical-pharmaceutical, food, building industry, cosmetics, landscape design and in veterinary practice [1, 2, 6].

In European countries, among medicinal plants for sowing areas, pot marigolds takes second place, beheading only the wild chamomile. Pot marigolds are widely cultivated also in Australia, Argentina, Mexico, Russia, the USA [6, 11, 12].

In the State Register of Russian Varieties are two cultivars of medical use – Kalta, Sakharovskaya oranzhevaya and two varieties of ornamental direction - Solnechnyi Luch, Piatnashka [3]. Varieties registered in other countries combine the traits of pharmaceutical raw materials with decorative features: the Belarusian cultivar Makhrovaya 2000; the Bulgarian ones – Kalenda 27-C, 32-T, 32-5S; the

Moldovan ones – Diana and Nataly; the Czech cultivar Plamen plus, the Japanese variety Calypso Orange.

For ornamental purposes, the calendula began to grow since the XV century in France. In Paris in the Luxembourg park the monument is built where the French Queen Marguerite de Valois Navarrese is holding a marigold flowers [2, 6, 12]. O.A. Smirnovsky in his book "The Ground Floriculture" (1912) mentions three ornamental varieties: Meteor, Favorite and Prince Oransky. There are old varieties Orange king (1927), Goldkugel, Radio, Chrysantha (1938), Plamen (1941), which are popular today and are used in the breeding process; in particular the last cultivar was used to create the ornamental variety Pacific [6]. The vast majority of varietal diversity (about 100 varieties) belong to group of ornamental use. They are characterized by large (10 cm) plain and double inflorescences, different shades of orange and yellow colors of tube and ligulate florets. There are varieties of cream, pale pink, crimson, green petals, mostly double. New varieties are divided into runty (15 to 30 cm) – Calypso, Fiesta Gitana, Pygmy, Kyendimen etc.; of middle height (30 to 45 cm) – Radio, Zelenoe serdtsce, Solntsce Egypta, Shelkovyi put', Geisha girl et al. and tall (45 to 85 cm) – Pacific, Zolotcse, Neon, Indian Prince, Orange King and others. The flowers of different marigold varieties are different in shapes: imbricate, radiant, similar to chrisanthemum, gerbera and anemone. In the flowers of imbricate type, the ligulate florets are wide imbricated located ligulate florets, the petals are curved outward. To this type belong the varieties Orange King, Kalta, Sakharovskaya oranzhevaya etc. The radiant flowers of the varieties Radio, Orangestrahlen, Sunshine have narrow shortened ligulate flowers arranged like the rays. The flores of chrysanthemum type of the marigold variety Chrysantha, Orange Monarch is characterized by twisted and fused in the form of needles, slightly curved in opposite directions petals of ligulate florets. Gerbera type flowers of the varieties Zelenoe serdtsce, Zheltoe serdtsce and others have the central disk consisting of small tubular florets which is framed by several rows of ligulate florets. In anemone type flowers of the variety Kablouna,

increased tubular flowers form a cushion around which are wide ligulate flowers disposed in one row [1, 2, 6].

Today, in the State Register of the Ukrainian Plant Cultivars Allowed to Distribution in the Ukraine there are no marigold varieties [4]. One way to wide implementation of this valuable crop is to create a variety which would be ornamental and characterized by high productivity and quality of raw materials. The source of starting material for breeding such varieties is genetic diversity of 145 samples focused in the marigold collection of the Research Station of Medicinal Plants of the Institute of Agroecology and Environment Use of NAAS (RSMP).

**The aim of the research** is to identify from the genetic diversity a source material for morphological, biological and economically useful traits to create variety for decorative use.

#### **Materials and methods of research.**

The evaluation of the collection samples was performed during 2012-2014 in breeding and seed production rotation RSMP, which is located in the eastern left bank Forest–Steppe of Ukraine at a height of 160 m above sea level. The location of the institution is determined by geographical coordinates: 50°04′ of north latitude and 30°06′ east longitude from Greenwich. The relief of the rotation fields is gentle slope of the second terrace of Sula river, the soil is chernozem low humus (1,61-2,43 %) weakly leached light loam. The weather conditions in 2012 and 2013 were characterized by high temperatures and lack of moisture in the spring and summer; the 2014 was favorable for the growth and development of the collection samples. In general, soil and climatic conditions during the research have been favorable for the cultivation of marigold and display of plants features.

In 1999 in the RSMP was started collecting of samples and forming of the marigolds collection. Currently, the collection includes 145 samples of 4 species: *Calendula officinalis* L., *C. arvensis* L. (C.ar.-11-33), *C. tripterocarpa* Rupr. (C.t.-11-34), *C. alata* Rech. (C.al.-11-32) from 18 countries, of which 38 samples form the trait collection of the genus *Calendula* L. The greatest part of the samples

originate from Ukraine - 65 (44,8 %), the next largest groups of samples are from Russia - 34 (23,4%) and Germany - 18 (12,4%), France - 4 (2,8%), Italy, the Netherlands and Japan - 3 (2,1%); from Germany, Israel, Poland, US-2 (1,4%); the smallest number are from the UK, Belarus, Switzerland, Bulgaria, India, Libya, Mongolia – by one sample (about 1%).

The field experiments were carried out in accordance with generally accepted methodology described by B.A. Dospekhov [5] and for medicinal marigold – by H.S. Lyevandovsky [8]. Sowing was carried out in optimal terms using hand drill to a depth of 2 cm. The parcels were one row of 2 m length with row spacing of 45 cm without replication. Phenological observations and biometric measurements, evaluation of marigold collection samples for economic and biological characteristics was performed by techniques of the Ukrainian State Service for Varieties Testing [7] and O.A. Porada [8].

To evaluate the marigolds samples for economic, biological and ornamental properties, techniques of DUS test (examination of marigold varieties for difference, uniformity and stability) and O.A. Porada were used applying 7 and 9-point scale and the graduation developed by us. The scales for specific features are indicated below at characterizing the samples.

Accounting of plant damage by pests and diseases was performed by standard methods [7, 8]. In the article, the quantitative characteristics and the relationships between the traits are shown on the average data for 2012–2014.

The mathematical processing of experimental data was made using computer software ANOVA [5].

### **Results of research.**

According recommendations of O.A. Porada, assessment of annual crops, which include marigold, for the suitability to landscape design should be conducted in a complex both on ornamental properties and biological-economical. To the former we have included: plant height, diameter of the bush, inflorescence diameter, diameter of the disk, color of ligulate and tubular flowers, inflorescence doubleness, originality. For assessment for economic and biological properties, a

such parameters were defined: seed productivity, duration of flowering, disease resistance, resistance to pests and drought resistance.

The height is one of the important traits in breeding for decoratively, where tall varieties or collection samples are used to cut and on beds, and the stunted ones – on the ridges, curbs, as potplants and others. According to the above mentioned methods, the height of the samples was evaluated by a 7-point scale: 1 point – very low (to 30 cm), 3 points – low (30-50 cm), 5 points – average (50-65 cm), 7 points – high (more 65 cm). According to results of the measurements, the collection samples are divided by height: 1 point – 18 samples, 3 points – 117 points 5 – 8, 7 points – 2 samples. The majority of the samples (117) were low in height. The samples Co-14-126 and Co-14-52 were considered as tall, they had a plant height of 65,5 cm and 66,2 cm respectively; the varieties Fiesta Gitana, Pygmy Golden, Apricot Pygmy, Cream Pygmy, Lemon Twist, Mandarin Twist – as the runty (the height not exceeding 30 cm).

The diameter of the bush is an important decorative feature that should be taken into account when choosing and design a composition. The bush diameter of the samples is assessed by 7-point scale: 3 points – small (25 cm), 5 points – average (25–50 cm), 7 points – large (50 cm). The collection samples were divided for the bush diameter into the following groups: small – 24 samples, average – 117, large – 4 samples. According to the measurements, the most spreading bush is characteristic of the samples Co-14-52 and Co-14-102 – 60,3 cm and 61,3 cm respectively, and the narrowest – the varieties Orange Gitana: 16,2 cm, but most samples had an average diameter of the bush. The diameter of the bush is closely connected with the disc diameter ( $r = 0,80$ ).

There were studied morphological traits that characterize the inflorescence: the inflorescence diameter, diameter of the disk, doubleness degree, color of ligulate and tubular florets.

One of the important features characterizing ornamentally is the inflorescence diameter. The inflorescence diameter was assessed by 9-point scale: 1 point – less than 3,0 cm, 3 points – 3,1–4,0 cm, 5 points – 4,1–6,0 cm, 7 points – 6,1–8,9 cm, 9

points – more than 9,0 cm. On this trait, according to scoring, the marigold samples were divided into the following groups: 1 point – 4 samples, 3 points – 13, 5 points – 103, 7 points – 23, 9 points – 2 samples. The majority of samples (103) has an average diameter of inflorescence. The biggest it value had the varieties Zolottse and Mandarin Twist: more than 9 cm, the lowest – the samples C.al.-11-32, C.ar.-11-33, C.t.-11-34, whose diameter ranged from 1,2 to 1,5 cm. Based on the results of the correlation analysis, the diameter of the inflorescence has moderate ( $r = 0,45$ ) relationship with doubleness.

The diameter of the disc provides decorative inflorescence and determines its shape. By this measure collectible samples were divided into categories: small (up to 1,2 cm or 3 points on 7-point scale) – 48 samples; medium (1,2–1,6 cm or 5 points) – 87 samples; large (1,6 cm or 7 points) – 10 samples. The largest disk diameter have the variety Mandarin Twist and the sample Co-14-35 – 1,9 cm; the smallest – the samples C.al.-11-32, C.ar.-11-33, C.t.-11-34, whose disc diameter ranged from 0,35 to 0,55 cm. The majority of samples (87) had an average diameter of the disc.

Doubleness of inflorescences is also an important decorative feature. Double inflorescences are larger and longer compared to non double [6]. The distribution of the collection samples by doubleness degree is as follows: 1 point – non double (1row) – 30 samples; 3 points – non double (2 rows) – 35 samples; 5 points – semi-double (3–6 rows) – 20 samples; 7 points – double (6–8 rows) – 50 samples; 9 points – double (over 8 rows) – 4 samples. And 6 samples are selected in individual group, which are population and have mixed type by doubleness degree. These samples do not have values that is why they will be from future research. The most decorative are the samples having double blossoms. Fig. 1 shows the degrees of doubleness that occur in marigold samples



Fig. 1 Degrees of doubleness manifestation in marigold inflorescences

The greatest doubleness degree was observed in the samples Co-14-130, Co-14-131; varieties Lemon Twist and Mandarin Twist, which had more than 8 rows of ligulate florets. The vast majority of samples (65) have non double inflorescence. According to the results of correlation analysis, and duration of flowering and doubleness are in moderate connection ( $r = 0,40$ ).

The color of the flowers is one of the main decorative features. It is estimated by the 9-point scale for ligulate and tubular flowers: 1 point – light yellow, 3 – yellow, 5 – orange–yellow, 7 – orange, 9 points – dark orange for ligulate florets and brown for the tubular. Coloring of ligulate edge and tubular median florets of collection samples covers the entire color scale. The main coloring types of ligulate florets are shown in Fig. 2 and the tubular florets in Fig. 3.







yellow

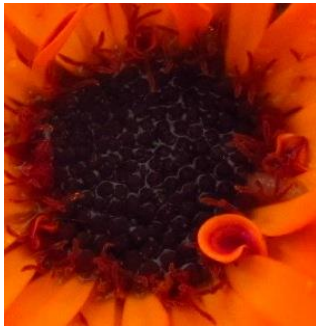


light yellow



light orange

Fig. 2 Coloring types of marigold ligulate florets



dark-brown



orange



orange-yellow



yellow



light-yellow

Fig. 3 Coloring types of marigold tubular florets

Distribution of the marigold collection samples for ligulate florets color is as such: light yellow – 4 samples, yellow – 35, orange–yellow – 21, orange – 73, dark orange – 6 samples. For tubular florets color, distribution of the samples is following: light yellow – 6 samples, yellow – 26, yellow–orange – 43, orange – 29, brown – 35 samples. And 6 samples were populations of heterogeneous coloration of ligulate and tubular florets which are sourced from expeditions and included in the collection. Such as they do not have values, they will be removed from future research.

The majority of the collection samples have orange color of ligulate and tubular florets. According to published data, high content of flavonoids and



carotenoids exposed samples of medicinal marigold with a dark orange color of ligulate flowers [11]. We selected varieties of Indian prince, Kablouna, Chernoe Serdtsce, Krasnyi Kover which had a dark orange color of the both ligulate and tubular florets.

The estimation of marigold collection samples for originality was carried out. We allocated the varieties Sherbet, Yazyki Plameni, Indian prince, Apricot Pygmy, Touch of Red, Bronze Beauty, Flashback mix having antotcyan color of the back side of ligulate florets. The varieties Radio, Orange Porcupine, Orangestrahlen had orange–yellow and orange color of flowers. Wherein edges of ligulate florets are tightened down, so inflorescence have radiant form. The variety Mandarin Twist has a bright orange color of ligulate florets, characterized by large blossoms and low growth. The variety Zen gold is also low, has many large blossoms of bright yellow color of ligulate florets. The variety Kablouna has orange color of the both ligulate and tubular florets, wherein the tubular florets are elongated that provides inflorescence of anemonelike form. The varieties Zelenoe serdtsce and Oranzhevoye serdtsce have median tubular florets of orange and green colors, around which are several rows of ligulate florets of orange and yellow color.

The ability of plants to keep decoratively, resisting pests and pathogens, is genetically controlled. During the research, which was conducted during the growing season, damage of collection samples by bean aphids, gray beet weevil, caterpillars of cabbage shovels and meadow butterfly was noted. Resistance against pests was evaluated by 9–point scale: 1 point – very unresistant, damaged on more than 85%; 3 – unresistant, damage within 61–85%; 5 – medium resistant, damage within 35-60%; 7 – resistant, damage ranging from 10% to 35%; 9 points – very resistant, the damage is slight or missing. The results of the observations showed weak resistance to pests complex of three samples, the average resistance of 133 samples and nine samples marked as resistant. Resistance to pests has a moderate correlation with bush diameter ( $r = 0,48$ ) and disc diameter ( $r = 0,46$ ).

Resistance to powdery mildew (*Sphaerotheca fuliginea f. calendulae*) was determined in the phase of budding – flowering and evaluated by 9-point scale: 1

point – very susceptible, damage more than 85%; 3 – non resistant, lesions within 60–85%; 5 – medium resistant, lesions within 35–60%; 7 – resistant, lesions ranging from 10% to 35%; 9 points – very resistant, lesions slight or absent. For resistance to powdery mildew, 17 collection samples were weak resistant, 117 – middle resistant and 11 – high resistant.

What is a natural phenomenon as drought adversely affects the decorative pattern of marigold collection samples, inhibiting growth and development. Therefore, we evaluated the samples for resistance to drought by 9-point scale: 1 point – very weak resistance, the plant dies; 3 – weak, dries more than 2/3 of the leaves and shoots; 5 – middle, dry leaves and more than 1/2 of the shoots; 7 - high resistance, the plant partially withers but recovered; 9 points – very high, plants are not affected. According to estimates, marigold collection samples are divided by resistance to drought as follows: 8 characterized as weakly resistant, 124 – medium resistant and 13 – resistant.

The highest resistant (8 points) to leaf-eating pests was the sample C.t.-11-34; to powdery mildew (7 points) – the varieties Touch, Chernoe serdtsce, Golden Beauty, Orange Monarch, Pacifik, Zen Orange, Lemon Twist; the samples Co-14-35, Co-14-42, Co-14-75, Co-14-76; drought (7 points) – the varieties Fiesta Gitana, Zen Orange, Kablouna, Lemon Twist, Mandarin Twist, Chernoe serdtsce; the samples C.t.-11-34, Co-14-66, Co-14-73, Co-14-74, Co-14-80, Co-14-96, Co-14-99. The varieties Chernoe serdtsce, Lemon Twist, Mandarin Twist are characterized by combined resistance to abiotic and biotic factors.

One of the main features of decoratively is flowering duration which is estimated by 7–point scale: 3 points – short (flowering to 30 days), 5 points – average (flowering 30 to 40 days), 7 points – long (more 40 days). For the duration of flowering, the collection samples were divided into categories: short – 5 samples, average – 107, long – 33. The longest blooming collection samples Co-14-165, the varieties Lemon Twist, Orange Gitana, Mandarin Twist and Volshebnoe Sary whose flowering duration is more than 44 days.

Seed productivity is an important trait that allows to multiply valuable sample or variety, in particular for use as an ornamental plant. The evaluation of samples for seed productivity was carried out according to 9–point scale: 1 point – very low (less than 5 g per plant), 3 points – low (5-10 g per plant), 5 points – middle (10-15 g per plant), 7 points – high (15-20 g per plant), 9 points - very high (more than 20 grams per plant). According to the results of accounting, the marigold collection samples are distributed by seed productivity: very low – 11 samples, low – 40, medium – 72, high – 17, very high – 5 samples. For the highest seed productivity (20 g / 1 plant) were identified 6 samples: C.t.-11-34, Co-14-40, Co-14-50, Co-14-94; the varieties Daisy Orange and Yazyki Plameni. There is moderate connection between seed productivity and plant height ( $r = 0,38$ ).

So, middle link exists between the individual economical and ornamental traits: resistance to pests on the one hand and bush diameter and inflorescence disk diameter on the other hand; flowering duration with doubleness and diameter of inflorescence; seed productivity and plant height. The decorative features between them have an medium (doubleness with diameter of inflorescence) and close (disk diameter with a bush diameter) connections. The identified relationships between the above mentioned traits contribute to the success of further breeding work in the decorative direction.

Integrated evaluation of the samples was defined by number of points assigned to the samples for individual characteristics. As a result of a comprehensive evaluation of 145 collection samples for ornamental and valuable economic characteristics, the most promising varieties are identified: Chernoe serdtsce, Zen Orange, Indian Prince and Mandarin Twist which had 83 by points. 85 samples revealed promising for certain traits – from 60 to 82 points. The remaining 56 samples are less promising in terms of decoration, they are valued within 39 and 60 points.

### **Conclusions**

1. The marigold collection numbering 145 samples from 18 countries is created in the RSMP.

2. A carried research found that by a comprehensive assessment of ornamental, economical and biological characteristics, most promising are the varieties Chernoe Serdtsce, Zen Orange, Indian Prince and Mandarin Twist.

3. Relationships between decorative and economic characteristics are identified: high ( $r = 0,80$ ) – between disc diameter and bush diameter; middle – between pests resistance on the one hand and bush diameter and disk diameter on the other hand (respectively  $r = 0,48$  and  $r = 0,46$ ); between doubleness and diameter of inflorescence ( $r = 0,45$ ); between flowering duration of on one hand and diameter and doubleness of inflorescence on the other hand (respectively  $r = 0,45$  and  $r = 0,40$ ); between seed productivity and plant height ( $r = 0,38$ ).

### ***Bibliography***

1. Aksenov E. S. Dekorativnye rastenija. T. II (Travjanistye rasteniia). Ėncyklopedi ja. prirody Rossii // E. S. Aksenov, Aksenova N. A. – M.: 1997. – 608 p.
2. Bashkirceva N. A. Kalendula – zolotye cvetki zdorov'ja / N. A. Bashkyrceva. – Krylov: 2008. – 128 p.
3. Gosudarstvennyj reestr selekcyonnyh dostyzhenyj, dopushhennyh k ispol'zovaniju v proizvodstve Rossijskoj Federacii/ - M ., 2014. – 441 p. // <http://www.gosort.com/>.
4. Derzhavnyj rejestr sortiv roslin, prydatnyh dlja poshyrennja v Ukrai'ni na 2014 r. (<http://vet.gov.ua/sites/default/files/ReestrEU-2014-06-16.pdf>).
5. Dosphehov B.A. Metodika polevogo opyta / B.A. Dosphehov. — M.: Kolos, 1985. — 365 p.
6. Ismagilov R.R. Kalendula / R.R. Ismagilov, D. A. Kostylev.— Ufa : BGAU, 2000. — 102 p.
7. Metodyka provedennja kvalifikacijnoi' ekspertyzy sortiv kvitkovo-dekorativnyh, efiroolijnyh, likars'kyh ta lisovyh roslin na prydatnist' do poshyrennja v Ukrai'ni. – K.: Derzhavna sluzhba z ohorony prav na sorty roslin, 2007.– p.1-80.

8. Metodicheskie ukazanija po selekcii i semenovodstvu nogotkov lekarstvennyh / sost. kand. biol. nauk G.S. Levandovskim. — M.: VILR, 1984. — 21 p.
9. Omeljuta V.P. Oblik shkidnykiv i hvorob sil's'kogospodars'kyh kul'tur / V. P. Omeljuta, I. V. Grygorovych, V. S. Chaban ta inshi // Za red. Omeljuty V. P. - K.: Urozhaj, 1986.- 246 p.
10. Porada O.A. Metodyka formuvannja ta vedennja kolekcij likars'kyh roslyn. / O.A. Porada. — Poltava : PP PDAA, 2007. — 50 p.
11. Sampiev A.M. Kalendula lekarstvennaja / A.M. Sampiev, M.R. Hochava.— Krasnodar : Sovetskaja Kuban', 2010. — 144 p.
12. Shelud'ko L. P. Likars'ki roslyny (selekcija i nasinnyctvo) / L. P. Shelud'ko, N. I. Kucenko. — Poltava: 2013. - 476 p.