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## MANIFESTATION OF MORPHOMETRIC INDICATORS AND VARIETARY TRAITS IN PLANTS OF THE GENUS *TAGETES* L.

**Actuality.** Today, landscape designers are required to introduce a new assortment of plants into culture, in particular annual ornamental crops.

**The purpose of the study** is to investigate the manifestation and relationships of morphometric indicators and varietal characteristics of plants of the genus *Tagetes* L.

**Materials and methods.** The research material was 10 varieties of marigolds: Orange Prince, Sugar and Spices, Moonlight, Hawaii, Red Brocade, Cupid Lemon, Bolero, Mandarin, Marietta and Manjestik. The following research methods were used: field – determination of morphometric indicators and varietal characteristics of plants and the duration of the flowering phase of marigolds; laboratory – determination of varietal characteristics of the plant, leaves and inflorescences; statistical – identification of relationships between the studied indicators.

**Research results.** The longest period of “beginning-mass flowering” was established in the varieties Red Brocade and Marietta (over 30 days). Medium-sized varieties were distinguished: Orange Prince, Moonlight, Hawaii and Manjestik. The Manjestik variety was noted for the number of inflorescences on the plant (97 pcs.). A semi-spreading plant habit and moderate branching of the plant were revealed in most varieties. The Hawaii variety was distinguished for leaf size. The largest baskets were noted in the varieties Orange Prince, Moonlight, Hawaii, Sugar and Spices. The type of flowers in the inflorescence of marigolds was established: tubular-reed, tubular and reed. The Marietta and Manjestik varieties were distinguished for the presence of a two-color basket. A strong relationship was established between the indicators: diameter and length of the basket with a peduncle, the indicator of plant height at the beginning of flowering and during full flowering; correlations of medium strength between the indicators: length of the basket with a peduncle and length of the peduncle; length and width of the leaf; as well as the inverse relationship between the number of inflorescences on the plant and the length and diameter of the basket.

**Conclusions.** The duration of the period “beginning-mass flowering” in varieties of marigolds of the genus *Tagetes* L. was established. Morphometric indicators of the plant in the flowering phase and the manifestation of varietal characteristics of the plant, leaf and inflorescences in varieties of marigolds were determined. Relationships between the studied indicators were noted.

**Key words:** marigolds, variety, duration of flowering, morphometric indicators, varietal characteristics.

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ПРОЯВ МОРФОМЕТРИЧНИХ ПОКАЗНИКІВ І СОРТОВИХ ОЗНАК  
У РОСЛИН РОДУ *TAGETES* L.

**Актуальність.** На сьогодні від ландшафтних дизайнерів вимагають впровадження в культуру нового асортименту рослин, зокрема однорічних декоративних культур.

**Мета дослідження** – дослідити прояв і взаємозв'язки морфометричних показників та сортових ознак рослин роду *Tagetes* L.

**Матеріали та методи.** Матеріалом досліджень було 10 сортів чорнобривців: помаранчевий принц, цукор і спеції, місячне сяйво, гаваї, червона брокада, купід лимон, болеро, мандарин, марієтта і манджестік. Використовували такі методи дослідження: польові – визначення морфометричних показників і сортових ознак рослин та тривалість фази цвітіння чорнобривців; лабораторні – визначення сортових ознак рослини, листків і суцвіть; статистичні – виявлення взаємозв'язків між досліджуваними показниками.

**Результати дослідження.** Встановлено найдовший період «початок – масове цвітіння» у сортів червона брокада і марієтта (понад 30 діб). Виділено середньорослі сорти: помаранчевий принц, місячне сяйво, гаваї і манджестік. Відмічено сорт манджестік за кількістю суцвіть на рослині (97 шт.). Виявлено в більшості сортів напіврозлогий габітус рослини та помірне гілкування рослини. Виділено сорт гаваї за розмірами листка. Відмічено найбільші кошики у сортів помаранчевий принц, місячне сяйво, гаваї, цукор і спеції. Встановлено тип квіток у суцвітті чорнобривців: трубчато-язичкові, трубчасті та язичкові. Виділено сорти марієтта і манджестік за наявність двоколірного кошика. Встановлено сильний взаємозв'язок між показниками діаметра та довжини кошика з квітконіжкою, показниками висоти рослини на початку цвітіння і під час повного цвітіння, кореляцію середньої сили між показниками довжини кошика з квітконіжкою і довжини квітконіжки, між довжиною і шириною листка; а також зворотний зв'язок кількості суцвіть на рослині з довжиною та діаметром кошика.

**Висновки.** Встановлено тривалість періоду «початок – масове цвітіння» у сортів чорнобривців роду *Tagetes* L. Визначено морфометричні показники рослини у фазі цвітіння та прояв сортових ознак рослини, листка і суцвіть у сортів чорнобривців. Відмічено взаємозв'язки між досліджуваними показниками.

**Ключові слова:** чорнобривці, сорт, тривалість цвітіння, морфометричні показники, сортові ознаки.

**Introduction. Relevance.** Currently, the diverse genetic potential of plants, in particular ornamental crops, has different areas of use: horticulture, green construction, pharmacology, cosmetology, and others. The gene pool of such plants is mainly concentrated in botanical gardens, dendrological parks, and research institutions in this area (Ishchuk, 2022). To increase the efficiency of breeding work, domestic scientists have developed models of plant varieties for each soil and climatic zone. Therefore, researchers recommend developing an assortment of crops for each climatic zone (Bagan et al., 2024; Trygub et al., 2023).

Modern floriculture requires landscape designers to introduce a new assortment of plants into the culture, including annual ornamental crops. Due to the long flowering period, relatively high resistance to drought and frost, annual plants occupy a leading place in flower and ornamental plantings of cities and villages. The assortment of seeds of annual ornamental plants is almost half represented by trademarks of domestic producers (Ishchuk, 2022).

The most common annual ornamental plants belong to the families Asteraceae Bercht. & J. Presl., Scrophulariaceae Juss., Solanaceae Juss., Caryophyllaceae Juss., Malvaceae Juss., Lamiaceae Martinov. Thus, the Asteraceae family has 83 species and 379 cultivars belonging to 43 genera. In particular, the genus *Tagetes* L. is represented by 59 species of plants and also has more than 600 forms and varieties that are distributed throughout the world (Ishchuk, 2022; Malyugina et al., 2024).

Growing annual plants can be combined in borders, flower beds, monochrome flower beds, geometric

flower beds and parterres. These plants are indispensable in flower beds in the summer-autumn period, when most perennial plants have already finished flowering. Low-growing and partly medium-growing plants are planted in the foreground of borders, flower beds, flower beds, flower beds, lawns, carpets, ribbons, to decorate flower groups and balconies (Kristin, 2012). Designers set requirements for these plants in terms of decorativeness, dust resistance, gas resistance and resistance to various pathogens (Vovk, 2023; Klymenko, 2004).

Tall plants and some medium-sized ones are used for single and group plantings on lawns, in the center of flower beds for lining roads. They are planted in the background for landscaping the walls of houses, intersections of roads, on the edges of forest parks, in the gaps between trees and bushes, if the plants can withstand shading. Flower garden groups are formed from a combination of annual plants of different heights: the tallest are placed in the center, and the lower plants are placed at the edges. Thus, the varietal diversity of the genus *Tagetes* can be represented by a monocultural garden – a tagetarium (Ishchuk, 2022). Studies have shown that the genus *Tagetes* L. in the Central Forest-Steppe is represented mainly by three species: *T. patula* L., *T. erecta* L., *T. tenuifolia* Cav. (Dydiv, 2023). Marigold *erecta* (*Tagetes erecta* L.) is the most common species, which combines a large number of varieties that differ in morphological characteristics (Mir et al., 2023; Malyugina & Smoilovska, 2023; Malyugina et al., 2024).

**The purpose of the study** is to investigate the manifestation and relationships of morphometric indicators

and varietal characteristics of plants of the genus *Tagetes* L., to establish the prospects for the economic use of the marigold assortment in the conditions of the Central Forest-Steppe of Ukraine.

**Materials and methods of the study.** The study was conducted during 2023–2024 in the conditions of the Central Forest-Steppe of Ukraine (central part of Poltava region – Myrhorod district). The study material was ten varieties of the genus Marigold (*Tagetes* L.): Orange Prince, Sugar and Spices, Moonlight, Hawaii, Red Brocade, Cupid Lemon, Bolero, Mandarin, Marietta and Mandzhestik (table 1).

Table 1

**Research material**

Variety	Type
Prince of Orange	<i>Tagetes erecta</i>
Sugar and Spice	<i>Tagetes erecta</i>
Moonlight	<i>Tagetes patula</i>
Hawaii	<i>Tagetes erecta</i>
Red Brocade	<i>Tagetes patula</i>
Cupid Lemon	<i>Tagetes erecta</i>
Bolero	<i>Tagetes erecta</i>
Tangerine	<i>Tagetes patula</i>
Marietta	<i>Tagetes patula</i>
Manjestic	<i>Tagetes patula</i>

The climate of this region is temperate continental with elevated temperatures and unevenly distributed precipitation during the spring-summer period. Soils are typical black soils. The plants of the studied varieties of marigolds were grown by the seedling method. They were planted in open ground in the first decade of May. The planting scheme of marigold seedlings for medium-sized varieties was 30 x 30 cm, and for low-growing varieties – 20 x 20 cm. During the experiment, the following research methods were used: field – determination of morphometric indicators and varietal characteristics of plants and the duration of the flowering phase of marigolds; laboratory – determination of varietal characteristics of the plant, leaves and inflorescences of marigolds; statistical – identification of relationships between morphometric indicators and varietal characteristics of marigolds using the method of correlation-regression analysis.

The studied varieties were studied according to the following indicators: duration of the period “beginning-mass flowering” (days), plant height at the beginning of the flowering phase (cm), plant height in the full flowering phase (cm), number of inflorescences on the plant (pcs.), plant habit, plant branching, plant aroma, leaf type, leaf length (cm), leaf width (cm), basket diameter (cm), basket length with peduncle (cm), peduncle length (cm), type of flower in the basket, number of basket

colors, basket color, main color of the flower, shape of the reed flower, dissection of the edge of the reed flower. The level of manifestation of varietal characteristics was determined according to the “Methodology for conducting the examination of plant varieties of the ornamental group for distinctness, uniformity and stability” (Kos-tenko et al., 2016).

The analysis of the obtained data of the results of the laboratory and field study was carried out using the statistical analysis package “Statistica 12.0” (Yeshchenko. et al., 2014).

**Research results and their discussion.** Recently, in landscape design, due to the selection of flowering plants and their growing technology, the range of annual flowering plants has significantly expanded. Their decorativeness, duration of flowering are the main criteria for evaluating flowers of ornamental crops, including marigolds. Every year, new species and varieties of plants are cultivated, which have a variety of color, shape, size of the flower, etc. (Dydiv, 2023; Vovk, 2023). Annual ornamental plants, due to their morphological diversity, long flowering, resistance to abiotic and biotic factors, make it possible to ensure the decorativeness of flower beds of various economic purposes during the summer-autumn period (Ishchuk, 2022). In the Central Forest-Steppe of Ukraine, plants of the genus *Tagetes* L. are widely cultivated. The most common species is the erect marigold (*Tagetes erecta* L.), but representatives of the spreading marigold (*Tagetes patula* L.) are also found (Malyugina et al., 2024).

According to the results of the research, the level of manifestation of morphometric indicators of the marigold plant during flowering was determined depending on the varietal properties (Table 2).

According to the average data of the studies, it was found that the shortest period of “beginning-full flowering” was characterized by the variety Cupid Lemon (15 days), and the longest – by the varieties Red Brokada and Marietta (over 30 days). In the remaining varieties of marigolds, the main flowering period was 21–27 days. According to the plant height indicator, the following varieties can be distinguished as medium-sized: Prince of Orange, Moonlight, Hawaii and Manjestic.

The remaining varieties were short-growing according to this indicator (less than 50 cm). At the same time, according to the increase in plant height for the period “beginning-full flowering”, the Orange Prince variety (34 cm) was distinguished. According to the number of inflorescences on the plant, the Mandzhestik variety can be distinguished – 97 pcs., and the lowest value of this indicator was noted in the variety Cupid Lemon (11 pcs.). According to research data, the manifestation of varietal characteristics of the plant in the studied varieties was established (Table 3).

Table 2

**Morphometric indicators of plants of marigold varieties of the genus *Tagetes L.* in the flowering phase (average for 2023–2024)**

Variety	Duration of the period “beginning-full flowering”, days	Plant height, cm			Number of inflorescences on the plant, pcs.
		at the beginning of the flowering phase	in the full flowering phase	±	
Prince of Orange	24	76	110	34	23
Sugar and Spice	21	42	53	11	13
Moonlight	23	83	102	19	18
Hawaii	23	88	97	9	19
Red Brocade	32	28	41	13	22
Cupid Lemon	16	30	43	13	11
Bolero	26	40	48	8	63
Tangerine	25	32	38	6	48
Marietta	33	37	42	5	36
Manjestic	27	63	70	7	97
average		51,9	64,3		35,0
lim <sub>min-max</sub>		23–92	33–114		4–106

Table 3

**The manifestation of varietal characteristics of the plant in varieties of the genus marigold *Tagetes L.***

Variety	Habit	Branching	Aroma
Prince of Orange	semi-spread	Moderate	scent
Sugar and Spice	semi-spread	Moderate	scent
Moonlight	semi-spread	Moderate	scent
Hawaii	semi-spread	Moderate	scent
Red Brocade	semi-spread	Moderate	scent
Cupid Lemon	semi-spread	Moderate	scent
Bolero	spreading	Strong	scent
Tangerine	semi-spread	Strong	scent
Marietta	semi-spread	Moderate	scent
Manjestic	semi-spread	Strong	scent

Table 4

**Manifestation of varietal leaf characteristics in varieties of marigolds of the genus *Tagetes L.* (average for 2023–2024)**

Variety	Variety Leaf type	Leaf length, cm		Leaf width, cm	
		X	lim <sub>min-max</sub>	X	lim <sub>min-max</sub>
Prince of Orange	pinnately dissected	13,8	13,0–15,0	8,3	7,5–9,5
Sugar and Spice	pinnately dissected	14,5	13,0–15,5	9,2	8,0–11,0
Moonlight	pinnately dissected	15,0	12,5–19,0	9,8	9,5–10,5
Hawaii	pinnately dissected	19,8	18,0–21,5	10,0	9,5–11,0
Red Brocade	pinnately dissected	10,8	10,5–11,0	6,3	6,0–6,5
Cupid Lemon	pinnately dissected	12,5	11,0–13,5	8,7	7,5–10,0
Bolero	pinnately dissected	14,5	12,0–16,5	9,0	7,5–10,0
Tangerine	pinnately dissected	12,2	11,0–13,5	7,2	6,5–8,0
Marietta	pinnately dissected	10,8	10,0–12,5	8,7	8,0–9,0
Manjestic	pinnately dissected	11,2	10,0–13,0	8,0	7,0–10,0
average (X)		13,5	10,0–21,5	8,5	6,0–11,0

According to research data, all varieties were characterized by a semi-spreading plant habit, except for the Bolero variety (spreading). Almost all varieties had moderate branching of the plant. Only the Bolero, Mandarin and Manjestic varieties had

strong branching and were characterized by a large number of flowers. In addition, all varieties of marigolds have an aroma.

The manifestation of varietal leaf characteristics in marigold varieties is presented (Table 4).

According to the average data of the research results, a pinnately dissected leaf type was established in all varieties of marigolds. According to the characteristics of the length and width of the leaf, the Hawaii variety was distinguished, which was characterized by the largest leaf size. According to the research results, the manifestation of varietal characteristics of the inflorescence in the studied varieties was determined (Table 5).

According to the results of studies on the diameter and length of the inflorescence and the length of the peduncle, it can be noted that the medium-sized varieties Prince of Orange, Moonlight and Hawaii, as well as the Sugar and Spices variety, had the largest baskets. The manifestation of varietal characteristics by flower type in marigold varieties was determined (Table 6).

According to the conducted studies, the type of flowers in the inflorescence of marigolds was established depending on the variety. Thus, the varieties Prince of Orange, Sugar and Spices, Moonlight and Hawaii were characterized by tubular-reed flowers of the basket. In the Prince of Orange variety, reed flowers of the inflorescence were found. The Red Brocade variety was characterized

by the presence of tubular-reed and reed flowers. The remaining varieties also had two types of flowers in the inflorescence: tubular and reed. According to the number of flowers in the inflorescence, the varieties Marietta and Manjestic can be distinguished, which were characterized by the presence of a two-color basket. The remaining varieties had the same color of inflorescence. According to the main varietal characteristics of the inflorescence of tubular (tubular-reed) and reed flowers of marigolds, the studied varieties can be characterized (Table 7).

So, the varieties Prince of Orange, Sugar and Spices and Hawaii with tubular-reed type of flowers had an orange color of the basket. In the variety Moonlight with a similar type of flowers, a light yellow color of the inflorescence was observed. The variety Prince of Orange was characterized by the presence of reed flowers in the basket of orange color and an intermediate shape, without a dissected edge.

The variety Cupid Lemon had tubular and reed flowers in the basket of light yellow color, with an intermediate shape and no dissected edge of the reed flower. The variety Bolero was also characterized by the presence of

Table 5

**Manifestation of varietal characteristics of inflorescences in varieties of marigolds of the genus *Tagetes* L. (average for 2023–2024)**

Variety	Basket diameter, cm		Basket length with peduncle, cm		Peduncle length, cm	
	X	<i>lim</i> <sub>min-max</sub>	X	<i>lim</i> <sub>min-max</sub>	X	<i>lim</i> <sub>min-max</sub>
Prince of Orange	7,8	6,5–9,0	7,2	6,0–8,0	2,3	1,5–3,5
Sugar and Spice	7,4	6,6–8,5	7,7	7,0–8,5	3,2	2,2–4,2
Moonlight	7,2	5,8–8,5	7,6	7,0–8,0	3,7	2,5–5,0
Hawaii	7,6	6,5–9,0	7,1	6,0–7,8	1,2	1,0–1,5
Red Brocade	5,1	4,0–6,0	5,8	5,0–7,0	2,0	1,5–2,3
Cupid Lemon	7,3	6,5–8,0	6,7	6,0–7,5	2,7	2,3–3,0
Bolero	5,8	5,2–6,0	5,3	5,0–5,7	1,4	1,0–1,5
Tangerine	4,6	4,0–5,0	5,2	4,5–6,0	1,7	1,2–2,3
Marietta	5,3	5,0–6,0	4,7	4,5–5,0	1,3	1,0–2,0
Manjestic	4,5	4,0–5,0	4,9	4,5–5,5	2,1	1,3–2,5
середнє (X)	6,2	4,0–9,0	6,2	4,5–8,5	2,3	1,0–5,0

Table 6

**Manifestation of characteristics by flower type and color in marigold varieties of the genus *Tagetes* L.**

Variety	Flower type	Number of colors
Prince of Orange	tubular-lingual	one
Sugar and Spice	tubular-lingual	one
Moonlight	tubular-lingual	one
Hawaii	tubular-lingual	one
Red Brocade	tubulo-reed and reed	one
Cupid Lemon	tubular-lingual	one
Bolero	tubular-lingual	one
Tangerine	Reed	one
Marietta	tubular and reed	two
Manjestic	tubular and reed	two

Table 7

**Manifestation of varietal characteristics of tubular (tubular-reed) and reed flowers in varieties of marigolds of the genus *Tagetes* L.**

Variety	Tubular (tubular-reed) flower		Reed flower			
	basket color	basic color of the flower	basket color	basic color of the flower	form	edge dissection
Prince of Orange	orange	orange	–	–	–	–
Sugar and Spice	orange	orange	–	–	–	–
Moonlight	light yellow	light yellow	–	–	–	–
Hawaii	orange	orange	–	–	–	–
Red Brocade	red	red	red	red	intermediate	Absent
Cupid Lemon	light yellow	light yellow	light yellow	light yellow	intermediate	Absent
Bolero	red	red	red	red	intermediate	Absent
Tangerine	–	–	orange	orange	intermediate	Absent
Marietta	–	dark yellow	–	red	flat	Absent
Manjestic	–	dark yellow	–	brown	flat	Absent

tubular and reed type of flowers, but the inflorescence had a red color, with an intermediate shape and no dissected edge of the reed flower. In the variety Red Brocade with tubular-reed and reed flowers, a red color of the basket with an intermediate shape and no dissected edge of the reed flower was noted.

The Marietta variety was characterized by the presence of dark yellow tubular flowers and red reed flowers of a flat shape without a cut edge. In the Manjestic variety, dark yellow tubular flowers and reed flowers with a basic brown color of a flat shape, without a cut edge, were observed.

Fig. 1 shows the inflorescences of the studied marigold varieties, which shows the diversity of the manifestation of varietal characteristics of the inflorescence and flowers according to the main characteristics.

According to the results of the correlation analysis, a strong relationship was established between the following indicators: diameter and length of the basket with a peduncle ( $r = 0.77$ ), as well as the plant height indicator at the beginning of flowering and during full flowering ( $r = 0.95$ ) (Fig. 2).

According to Fig. 2, an increase in the marigold inflorescence was noted depending on the size of its diameter and length, as well as an increase in the plant height indicator during the flowering phase of marigolds.

Also, correlations of medium strength were noted between the studied indicators: the length of the basket with the peduncle and the length of the peduncle ( $r = 0.64$ ); the length and width of the leaf ( $r = 0.64$ ); as well as the inverse relationship of the number of inflorescences on the plant with the length ( $r = -0.61$ ) and the diameter of the basket ( $r = -0.51$ ) (Fig. 3).

According to Fig. 3, a dependence of the increase in size between the length of the basket with a peduncle



**Fig. 1. Inflorescences of marigold varieties**

and the length of the peduncle, as well as an increase in the parameters between the length and width of the leaf, was established. In addition, it was noted that with

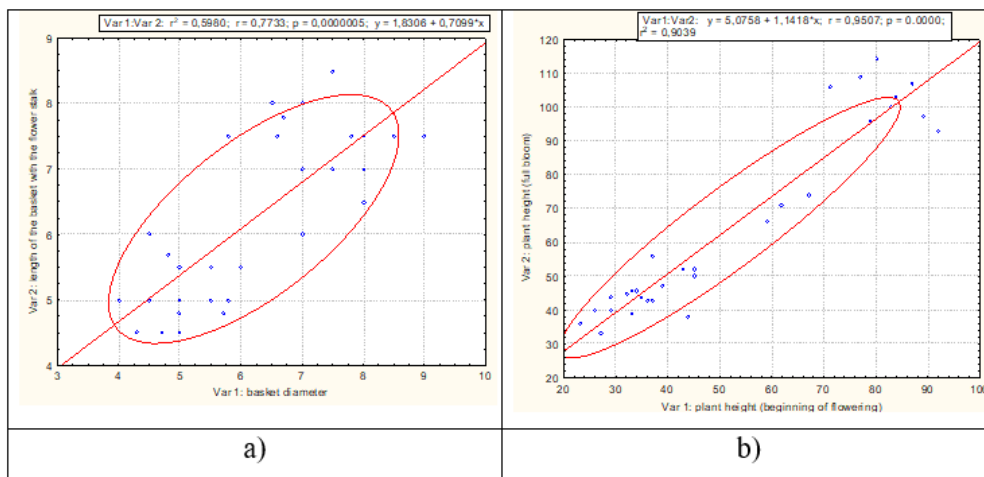


Fig. 2. Correlations: a) between the diameter and length of the basket with a peduncle; b) plant height at the beginning of flowering and during full flowering

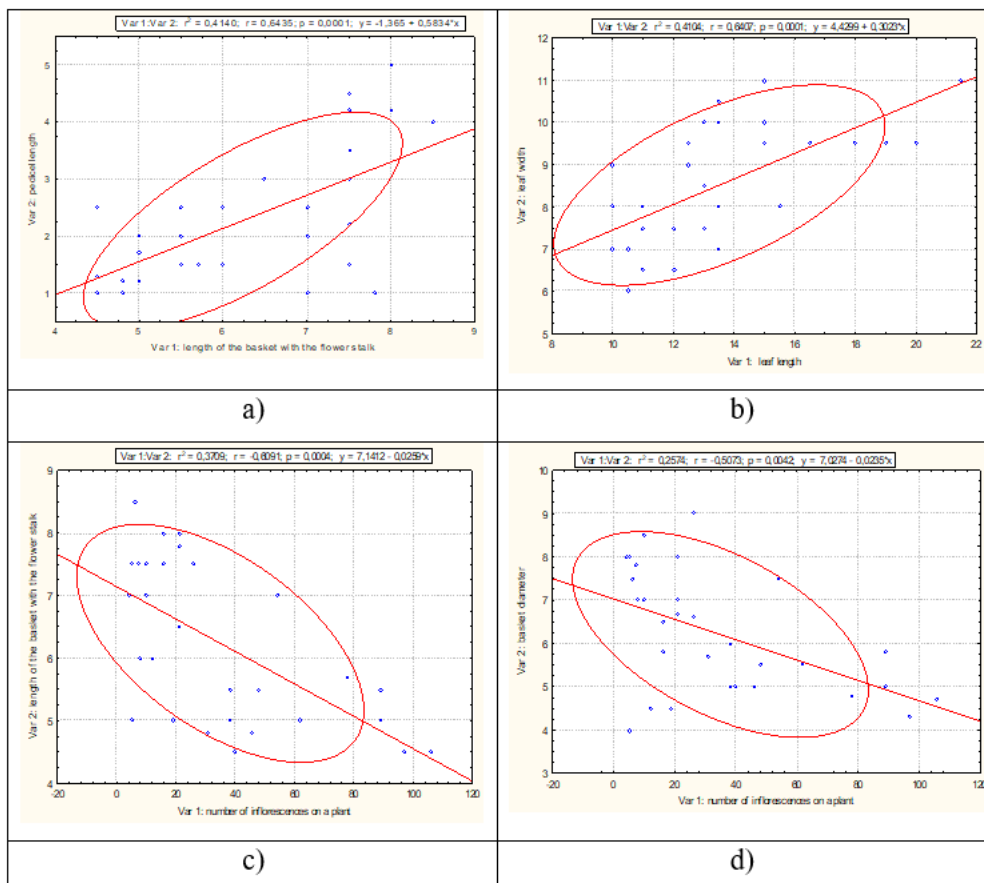


Fig. 3. Correlations: a) between the length of the basket and the length of the peduncle; b) between the length and width of the leaf; c) between the number of inflorescences on the plant and the length of the basket; d) between the number of inflorescences on the plant and the diameter of the basket



an increase in the size of the inflorescence (length and diameter of the basket), a decrease in the number of inflorescences on the plant was observed.

#### Conclusions

The duration of the period “beginning-full flowering” in varieties of marigolds of the genus *Tagetes L.* was established. Morphometric indicators of the plant in the studied varieties in the flowering phase were determined. The manifestation of varietal characteristics of the plant, leaf and inflorescences in varieties of marigolds was studied.

An increase in the inflorescence of marigolds was noted depending on the size of its diameter and length, as well as an increase in the plant height indi-

cator during the flowering phase of marigolds. A dependence of the increase in size between the length of the basket with a peduncle and the length of the peduncle, as well as an increase in the parameters between the length and width of the leaf, was established. In addition, it was noted that with an increase in the size of the inflorescence (length and diameter of the basket), a decrease in the number of inflorescences on the plant is observed.

The prospect of economic use of marigolds is their cultivation in landscape compositions: low-growing varieties - for borders and flower beds, medium-growing - to create color accents in the center of flower beds and in the background of the garden.

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**Bahan A.V.** – idea, concept and design of the study, collection and analysis of literature, statistical analysis of data, conclusions, correction of the article;

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**Hapon S.V.** – participation in writing the article, correction of the article;

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