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INTERRELATION OF DECORATIVE CHARACTERISTICS OF VARIETIES *PAEONIA SUFFRUTICOSA* ANDREWS DURING INTRODUCTION

Research article

Abstract

The article presents data on the study of biological and morphological characteristics of 15 varieties of *Paeonia suffruticosa* Andrews during introduction in the conditions of the forest–steppe zone of the Bashkir Cis–Ural. 13 quantitative and 21 qualitative features were analyzed. Their research was carried out in accordance with the “Test methodology for distinctness, uniformity and stability”. The phenotypic variability of quantitative parameters was studied. High variability was found for the traits “maximum plant height”, “shoot regrowth length” and “pedicel length”, medium – for “maximum shoot thickness”, “length and width of the leaf at the first axillary bud”, “maximum peduncle thickness”, “flower diameter”. A positive high correlation was noted between the flower diameter and the length of the longest tepal (0,75). The revealed patterns are of interest for building a model of paeony varieties and using them in plant breeding.

Keywords: *Paeonia suffruticosa* Andrews, varieties, variability, correlation coefficient, botany, introduction.

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ВЗАИМОСВЯЗЬ ДЕКОРАТИВНЫХ ПРИЗНАКОВ СОРТОВ ДРЕВОВИДНЫХ ПИОНОВ ПРИ ИНТРОДУКЦИИ

Научная статья

Аннотация

В статье представлены данные по изучению биолого-морфологических признаков 15 сортов древовидных пионов (*Paeonia suffruticosa* Andrews) при интродукции в условиях лесостепной зоны Башкирского Предуралья. Проанализированы 13 количественных признаков и 21 качественный. Их исследование осуществляли в соответствии с «Методикой проведения испытаний на отличимость, однородность и стабильность». Изучена фенотипическая изменчивость количественных параметров. Высокая вариабельность установлена у признаков «максимальная высота растения», «длина отрастания побега», и «длина цветоножки», средняя – у «максимальная толщина побега», «длина и ширина листа у первой пазушной почки», «максимальная толщина цветоножки», «диаметр цветка». Отмечена положительная высокая связь между диаметром цветка и длиной самого длинного листочка околоцветника (0,75). Выявленные закономерности представляют интерес для построения модели сортов пиона и использования в селекции растений.

Ключевые слова: *Paeonia suffruticosa* Andrews, сорта, изменчивость, коэффициент корреляции, ботаника, интродукция.

1. Introduction

The ancient genus *Paeonia* L. includes more than 30 species. In addition to herbaceous paeonies, in which the aerial part dies off by winter, it includes semi-shrub and shrub forms with perennial woody shoots [7].

The tree-like *Paeonia* has been cultivated for more than 2000 years, being the national flower in China [11]. It is China that is the center of origin, evolution and main diversity of all types of *Paeonia suffruticosa* Andrews, as well as the center of development of its varieties [11]. At present, they are distributed in nature in East Asia, the Mediterranean, and the Caucasus [1].

Not a single shrub, except for a tree-like *Paeonia*, can boast of such large flowers in combination with their quantity and fragrance, as well as the longevity of the bush (specimens are known at the age of 300 and even 500 years) [9].

The bushes of tree *Paeonia* grow slowly; as it grows, the number of flowers per bush increases annually and can reach 30–70 [10]. The flowers have the shape of a bowl or ball (there are non–double, semi–double and double varieties), open on the tops of the shoots in late May – early June and bloom for two weeks, and in cool weather even longer [8].

The aim of the work was to study the main morphological and decorative features of varieties of tree-like *Paeonia* in the conditions of the Republic of Bashkortostan, to identify their phenotypic variability and correlation for further breeding work.

2. Materials and methods of research

The South–Ural Botanical Garden–Institute of Ufa Federal Research Centre of Russian Academy of Sciences (hereinafter referred to as SUBGI UFRC RAS) located in the forest–steppe zone of the Bashkir Cis–Ural. Climatically, this region is characterized by a large amplitude of temperature fluctuations in its annual course, instability and lack of precipitation, and a rapid transition from severe winters to hot summers [7].

The objects of research were 15 varieties of tree-like paeonies (*Paeonia suffruticosa* Andrews) ('White Jade', 'Pearl Wind', 'Red Flower', 'Jade Bead', 'Peach under the Snow', 'Transparent Dew', 'Purple Butterfly in Sunset', 'Purple Ocean', 'Rainbow Drop', 'Pink Powder', 'Pink Lotus', 'Pink Glow Garden', 'Warm Wind', 'Purple', 'Lan Tian Yu'). The studies were carried out in 2019–2021 in perennial plantings of paeonies at the site of the Laboratory of Introduction and Breeding of Flower Plants of the SUBGI UFRC RAS. Since paeonies are most decorative in 4–5 years of cultivation, plants were selected for study at the appropriate age, planted according to the 100x100 cm scheme under the same agrotechnical conditions. The repeatability of each variant of the experiment was 5 individuals.

Determination of decorative features was carried out in accordance with the Methodology for testing for distinctness, uniformity and stability, approved by the State Commission of the Russian Federation for testing and protection of breeding achievements [6]. The description of each variety was carried out according to 34 traits, including both quantitative and qualitative indicators (table 1). It is known that qualitative features that are expressed in discrete degrees are obvious and independently expressed; quantitative – cover the entire range of variation from one extreme value to another [2].

Table 1 – The main quantitative and qualitative features of paeonies

No.	Quantitative features
1	Maximum height, cm
2	The length of shoot growth at the very top, cm
3	The maximum thickness of the shoot at the very top, cm
4	Number of branches from the base, pcs.
5	Leaf length at the first axillary bud, cm
6	Maximum leaf width at the first axillary bud, cm
7	Width of the side segment of the sheet, cm
8	Pedicle length, cm
9	The maximum thickness of the pedicel, cm
10	Flower diameter, cm
11	Length of the longest tepal, cm
12	Maximum width of the longest tepal, cm
13	Number of carpels, pcs.
14	Quality features
15	Plant appearance
16	The main color of the leaf bud
17	The main color of the shoot during budding
18	Waviness of the edge of the sheet
19	Downiness of the lower surface of the leaf
20	Basic leaf color
21	Petiole coloring
22	Anthocyanin leaf color
23	The main color of the peduncle
24	Bud opening
25	Flower doubleness level
26	Flower position
27	Flower coloring
28	Type of staining of the outer petals
29	The main color of the pigment spot
30	Flower fragrance
31	The main color of the filament
32	Basic coloration of anthers
33	Shape of the staminodial disc
34	Basic coloration of the staminodial disc
35	The main color of the stigma

Qualitative traits are more tightly controlled by genes and are more stable. As a result, their manifestation is relatively less dependent on fluctuations in external environmental conditions and is discontinuous [4]. Quantitative traits are determined by a large number of genes and are less tightly controlled by them. Due to the lower stability and strong dependence on fluctuations in environmental conditions, their manifestation is continuous [2].

The level of variability of each trait was determined using the S.A. Mamaev: CV <7% – very low; CV 8–12% – low; CV 13–20% – average; CV 21–30% – increased; CV 31–40% – high; CV >40% is very high [5]. Statistical processing of the material was carried out by the method of correlation analysis according to the generally accepted method [3].

3. The research results

As a result of the study, it was revealed that 47% of the studied varieties belong to the category of high (above 100 cm), 33% – medium (70–100 cm) and 20% – low (below 70 cm). On the basis of “the length of the shoot growth at the very top”, 53% of the varieties have a long stem (more than 35 cm), 47% have a medium stem (20–35 cm). It was noted that 53% of cultivars have thick shoots (more than 9 mm), 47% have medium thickness (6–9 mm). It is shown that most varieties (87%) have a large number of branches from the base of the shoot (more than 4 pieces), the remaining 13% – the average (3–4 pieces).

On the basis of “leaf length at the first axillary bud”, 74% of varieties have a leaf of medium length (17–25 cm), 13% – long (more than 25 cm), 13% – short (less than 17 cm). It was revealed that 60% of cultivars have leaves of medium width (18–28 cm), 40% – narrow (less than 18 cm). It was noted that in all studied varieties the lateral segments of the leaf are wide (more than 3,5 cm).

It is shown that 47% of varieties have a pedicel of medium length (5–8 cm), 33% – long (more than 8 cm), 20% – short (less than 5 cm). On the basis of the “maximum thickness of the pedicel”, 53% of the studied varieties have a pedicel of medium thickness (4–6 mm), 47% have a thick pedicel.

It was revealed that 73% of cultivars have a medium-sized flower (14–20 cm), 27% have a small flower (less than 14 cm). On the basis of “the length of the longest tepal” 53% of cultivars have a leaflet of medium length (7–11 cm), 47% have a short one (less than 7 cm). On the basis of “the maximum width of the longest tepal” 73% of varieties have leaves of medium width (5–9 cm), 27% – narrow (less than 5 cm).

It was noted that 80% of varieties have an average number of carpels (3–6 pcs.), 13% – many (more than 6 pcs.), 7% – few (less than 3 pcs.).

It is shown that in terms of plant appearance, more than half of the cultivars (53%) belong to the intermediate type, 34% to spreading, 13% to vertical. The main color of the leaf bud immediately after regrowth is pink in 53% of the varieties, light green in 34%, and red in 13%. The main color of the shoot during the budding period is green in 66% of the varieties, and pale yellow-green in 34%.

The waviness of the leaf edge is absent in 73%, in the remaining 27% it is observed. In 60% of the varieties, there is no such feature as “pubescence of the lower surface of the leaf”, in 40% – pubescence is noticed. In most cultivars (66%), the main leaf color is green, in 27% it is yellow-green, in 7% it is dark green.

All varieties have a colored petiole. In 66% of the varieties, the anthocyanin color of the petiole is absent, in 34% it is observed.

In most cultivars (73%), the main color of the pedicel is pale green, in 20% it is green, in 7% it has a different shade. All varieties have fast bud opening.

A very important feature is the level of doubleness of the flower. In 60% of varieties, the flower is semi-double, in 33% it is double, and in 7% it is simple. The position of the flower on the second day after blooming: in all varieties it is vertical.

In terms of flower color, half of the studied varieties (53%) have pink shades, 33% have white, 7% have purple, and 7% have other shades.

Separately, the type of coloring of the outer petals is considered as a form of additional coloring of the flower. In 53% of cultivars, a spot stands out at the base of the petal, in 33% there is no additional staining, in 14% – stripes are added to the spot. As for the main color of the pigment spot, in 53% of the varieties it is purple, 7% – pink, 7% – black.

It was revealed that the majority of varieties (93%) have an aroma that varies from weak to strong, 7% have no aroma.

The main color of the filament is pink in 87%, purple in 13%. In all varieties, the main color of the anthers is yellow. According to the shape of the staminodile disc, it was found that in 53% of the varieties it is bottle-shaped, in 27% it is in the form of a “palm fruit”, in 20% it is an open disc. In 47% of varieties, the main color of the staminodial disk is purple, in 27% it is pink, and 13% each is white, cream or another shade. The main color of the stigma varies: in 73% of the varieties, it is pink, in 13% it is red, in 7% it is red-purple or other.

Additionally, studies were carried out in order to identify the strength of the mutual influence of the main quantitative traits in these varieties of tree-like paeonies. The data presented in table 2 indicate a different degree of variability of quantitative traits in cultivars of *Paeonia*. Thus, the maximum thickness of the shoot at the very top, the length and width of the leaf at the first axillary bud, the maximum thickness of the pedicel, the diameter of the flower, the length and width of the longest tepal have an average level of variability; the width of the lateral segment of the leaf, the number of carpels – increased; the maximum height of the plant, the length of the regrowth of the shoot, the length of the pedicel – high; the number of branches from the base is very high.

Table 2 – Variability of quantitative characteristics of the varieties of *Paeonia suffruticosa*

No.	Feature	Medium	Error	Dispersion	Standard deviation	The coefficient of variation, %
1	Maximum height, cm	83,50	7,29	1063,42	32,61	39,05
2	The length of shoot growth at the very top, cm	41,10	3,07	188,62	13,73	33,41
3	The maximum thickness of the shoot at the very top, cm	0,95	0,03	0,03	0,17	18,54
4	Number of branches from the base, pcs.	11,85	1,51	46,02	6,78	57,25
5	Leaf length at the first axillary bud, cm	20,20	0,86	14,80	3,84	19,04
6	Maximum leaf width at the first axillary bud, cm	19,85	0,80	12,97	3,60	18,14
7	Width of the side segment of the sheet, cm	9,75	0,50	5,14	2,26	23,26
8	Pedicle length, cm	7,65	0,61	7,50	2,73	35,80
9	The maximum thickness of the pedicel, cm	0,64	0,02	0,01	0,11	17,85
10	Flower diameter, cm	15,50	0,54	5,94	2,43	15,73
11	Length of the longest tepal, cm	6,67	0,28	1,63	1,28	19,17
12	Maximum width of the longest tepal, cm	5,52	0,23	1,06	1,03	18,68
13	Number of carpels, pcs.	5,55	0,35	2,57	1,60	28,92

Based on the data of the correlation matrix, we will consider different degrees of closeness of the relationship of each quantitative trait of varieties of paeonia with other parameters (table 3).

Table 3 – Correlation matrix

Признаки	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1,00												
2	0,31	1,00											
3	0,60**	0,62**	1,00										
4	0,54*	0,33	0,54*	1,00									
5	0,24	0,44*	0,50*	0,50*	1,00								
6	0,46*	0,62**	0,35	0,49*	0,52*	1,00							
7	0,28	0,37	0,38	0,33	0,64**	0,45*	1,00						
8	0,28	0,16	0,41	0,35	0,41	0,33	0,17	1,00					
9	0,60**	0,43	0,39	0,40	0,52*	0,68**	0,55*	0,23	1,00				
10	0,57**	0,57**	0,64**	0,56**	0,40	0,54*	0,49*	0,63**	0,30	1,00			
11	0,31	0,34	0,41	0,21	0,19	0,43	0,47*	0,42	0,01	0,75**	1,00		
12	0,33	0,05	0,08	-0,23	-0,27	0,04	0,22	-0,15	0,35	0,09	0,12	1,00	
13	0,07	0,04	0,14	0,24	0,27	0,21	0,14	0,30	0,10	0,28	0,33	0,05	1,00

A moderate positive relationship was found between the maximum plant height and the maximum leaf width at the first axillary bud (0,46), the shoot growth length and leaf length at the first axillary bud (0,44), the number of branches from the base and the maximum leaf width at the first axillary bud (0,49), maximum leaf width at the first axillary bud and width of the lateral leaf segment (0,45), width of the lateral leaf segment and flower diameter (0,49), width of the lateral leaf segment and length of the longest tepal (0, 47).

A positive average relationship was established between the maximum plant height and the maximum shoot thickness at the very top (0,60), the maximum plant height and the number of branches from the base (0,54), the maximum plant height and maximum peduncle thickness (0,60), the maximum plant height and flower diameter (0,57), shoot regrowth length and maximum shoot thickness at the uppermost part (0,62), shoot regrowth length and maximum leaf width at the first axillary bud (0,62), shoot regrowth length and diameter flower (0,57), the maximum thickness of the shoot at the very top and the number of branches from the base (0,54), the maximum thickness of the shoot at the very upper part and flower diameter (0,64), number of branches from the base and leaf length at the first axillary bud (0,50), number of branches from the base and flower diameter (0,56), leaf length at the first axillary bud and maximum leaf width at the first axillary bud (0,52), leaf length at the first axillary bud and width of the lateral leaf segment (0,64), leaf length at the first axillary bud and maximum thickness of the peduncle (0,52), maximum leaf width at of the first axillary bud and the maximum thickness of the pedicel (0,68), the maximum width of the leaf at the first axillary bud and the diameter of the flower (0,54), the width of the lateral leaf segment and the maximum thickness of the pedicel (0,55), the length of the pedicel and the diameter of the flower (0,63).

A positive high correlation was found between the flower diameter and the length of the longest tepal (0,75).

In our studies, the maximum plant height had a positive moderate relationship with the maximum leaf width at the first axillary bud (0,46); a positive average relationship with the maximum thickness of the shoot at the very top (0,60), the number of branches from the base (0,54), the maximum thickness of the pedicel (0,60) and the diameter of the flower (0,57).

The shoot regrowth length at the uppermost part showed a moderate positive relationship with the leaf length at the first axillary bud (0,44); an average positive relationship with the maximum shoot thickness at the uppermost part (0,62), the maximum leaf width at the first axillary bud (0,62) and the flower diameter (0,57).

The maximum shoot thickness at the uppermost part positively correlated with the number of branches from the base (0,54), leaf length at the first axillary bud (0,50) and flower diameter (0,64).

The number of branches from the base had a positive moderate relationship with the maximum leaf width at the first axillary bud (0,49); a positive mean relationship with leaf length at the first axillary bud (0,50) and flower diameter (0,56).

The leaf length at the first axillary bud showed a positive mean relationship with the maximum leaf width at the first axillary bud (0,52), the width of the lateral leaf segment (0,64), and the maximum thickness of the pedicel (0,52).

The maximum leaf width at the first axillary bud positively moderately correlated with the width of the lateral leaf segment (0,45); positively moderate with a maximum pedicel thickness (0,68) and flower diameter (0,54).

The width of the lateral leaf segment showed a positive moderate relationship with the diameter of the flower (0,49) and the length of the longest tepal (0,47); positive average with the maximum thickness of the pedicel (0,55).

4. Conclusions

Thus, based on the analysis of the variability of the varieties of *Paeonia suffruticosa*, it was found that the following morphological features have the highest variability (wide reaction rate): the width of the lateral leaf segment, the number of carpels, the maximum height of the plant, the length of the shoot regrowth, the length of the pedicel, the number of branches from the base of the shoot. The smallest variability (narrow reaction rate) was found for the traits: maximum thickness of the shoot at the very top, length and width of the leaf at the first axillary bud, maximum thickness of the pedicel, flower diameter, length and width of the longest tepal.

Correlation analysis revealed a positive close relationship between the diameter of the flower and the length of the longest tepal (0,75).

The results obtained are statistically substantiated and can be applied to breeding work on the selection and decorativeness of varieties of *Paeonia suffruticosa*.

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Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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