SCIENTIFIC ARTICLE

Study of quantitative characteristics of three cultures (peonies, hostas, irises) for their use in urban landscaping

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Abstract

The purpose of this study is a scientifically based selection of representatives of the genera *Paeonia* L., *Hosta* L. and *Iris* L., promising for use in urban landscaping. The choice of research objects is determined by three criteria. These are: 1) representatives of the genera *Paeonia*, *Hosta* and *Iris* – large generic complexes with a large number of cultivars; 2) their cultivars are characterized by a wide morphological diversity; 3) in Russia, these cultures have long been actively used in landscape design. Their own set of characteristics has been studied for them. These signs are important for the selection of plants used in the greened objects of the city. The genus *Paeonia* is represented by a sample of 19 cultivars of *P. lactiflora* Pall. with a Japanese flower shape. The variability of three quantitative characteristics was studied – the length of the stem, its thickness at the base and the diameter of the flower. The genus *Hosta* is represented by a sample of 23 names. The variability was studied according to four characteristics – the length and width of the leaf blade, the leaf area, and the length of the petiole. The genus *Iris* is represented by a selection of 10 names. The variability of six characteristics was studied – the height of the plant, the number of flowers on the peduncle, the length of the flower and the width of the flower, the length and width of the leaf blade. Statistical processing of the obtained data was carried out using the program "Statistica Base". Classical methods of data processing are used. The development of models of flower beds is carried out using the AutoCAD program. From the total composition of the sample, promising varieties and forms were selected for each culture under study. In representatives of the genus *Paeonia* – this is the cultivar 'Bu-Te'. For the genus *Hosta*, these are the cultivars 'Frances Williams' and 'Liberty'. In the genus *Iris*, it is a form of natural origin *I. sibirica* f. *albiflora*. Based on the data obtained, 3 mixborders were designed with the participation of these cultivars and one form of natural origin.

Keywords: botanical garden, collections, flower arrangements, ornamental herbaceous plants.

Resumo

Estudo das características quantitativas de três culturas (peônias, hostas, íris) para uso em paisagismo urbano

O objetivo deste estudo foi selecionar cientificamente representantes dos gêneros *Paeonia* L., *Hosta* L. e *Iris* l., promissores para uso em paisagismo urbano. A escolha dos objetos de estudo foi determinada por três critérios: 1) grandes complexos genéricos com um grande número de variedades; 2) suas variedades são caracterizadas por uma ampla variedade morfológica; 3) na Rússia, essas culturas são usadas há muito tempo e ativamente no paisagismo. Um conjunto de sinais foi estudado para estas espécies. Os autores consideram essas características importantes para a seleção de plantas usadas nas instalações verdes da cidade. O gênero *Paeonia* é representado por uma amostra de 19 variedades de *P. lactiflora* Pall com uma forma de flor japonesa. A variabilidade de três características quantitativas estudadas foram o comprimento do caule, espessura na base e o diâmetro da flor. O gênero *Hosta* é representado por uma amostra de 23 nomes. A variabilidade foi investigada em quatro características: comprimento e largura da lâmina da folha, a área da folha, o comprimento do pecíolo. O gênero *Iris* é representado por uma amostra de 10 nomes. A variabilidade de seis características investigada consistiu em altura da planta, número de flores no pedúnculo, comprimento da flor e largura da flor e, comprimento e largura da lâmina foliar. O processamento estatístico dos dados obtidos foi realizado usando o programa "STATISTICA Base". Foram utilizadas técnicas clássicas de processamento de dados. O desenvolvimento de modelos de canteiros de flores foi feito usando o programa AutoCad. A composição geral da amostra, variedades e formas promissoras são destacadas para cada cultura estudada. Nos representantes do gênero *Paeonia* é a variedade 'Bu-Te'. Para o gênero *Hosta*, são as variedades 'Frances Williams' e 'Liberty'. Iris é uma forma natural de *I. sibirica* f. *albiflora*. Com base nos dados obtidos, 3 canteiros de flores foram projetados com a participação de dados de variedades e formas.

Palavras-chave: arranjos florais, coleções, jardim botânico, plantas herbáceas ornamentais.

Introduction

In the XXI century, the process of globalization has a significant impact on the development of botanical gardens. According to one of the actively developing modern trends, botanical gardens located within cities should be their structural part in territorial and functional aspects (Prokof'eva and Vasil'ev, 2019). At the same time, botanical gardens located on the territory of large cities can implement appropriate specific areas of work. This is an experimental study of the mechanisms of resistance in a wide range of plants (Schipper, 2017; Hopton et al., 2017) in the environmental conditions of large cities. As well as long-term forecasting of urbanophytocenosis development within the framework of an ever-increasing anthropogenic load (Kopylov, 2020; Zykova et al., 2021; Chernyshenko, 2021). This is especially relevant, since the deterioration of the environmental situation in modern large cities, where, according to statistical data, more than 70% of Russians live, it has already become obvious.

Green spaces perform various functions in the formation of the urban environment: sanitary, architectural, aesthetic, emotional and psychological. The arrangement of the landscape in urbanized territories is an integral part of the infrastructure, which is necessary to ensure a comfortable human life. The solution to this problem can be considered the active use of landscape architecture methods (Kulikova, 2021) to form a full-fledged environment in accordance with aesthetic, functional and environmental requirements (Kasimova et al., 2020; Zubair, 2020). It is advisable to use decorative herbaceous perennials in urban landscaping. With their help, it is possible to increase the period of decorative flower arrangements (in central Russia, annual flowers are decorative from June to August, perennial – from late April to early October), reduce the cost of planting and caring for them.

The purpose of the presented study is a scientifically based selection of representatives of the genera *Paeonia* L., *Hosta* L. and *Iris* L., not native to the flora of Central Russia, but promising for cultivation in this region and suitable for use in landscape compositions at urban public facilities.

Materials and Method

The research work presented in this article was carried out in the period from 2018 to 2021 on the base of the collections of the laboratory of ornamental plants in the Main Botanical Garden of the Russian Academy of Sciences.

Representatives of three genera *Paeonia*, *Hosta* and *Iris* were used as model objects: (Figure 1). The choice of research objects is determined by three main criteria. These are: 1) large generic complexes with a large number of cultivars; 2) their cultivars are characterized by a wide morphological diversity; 3) in Russia, these crops have long been actively used in landscape design.
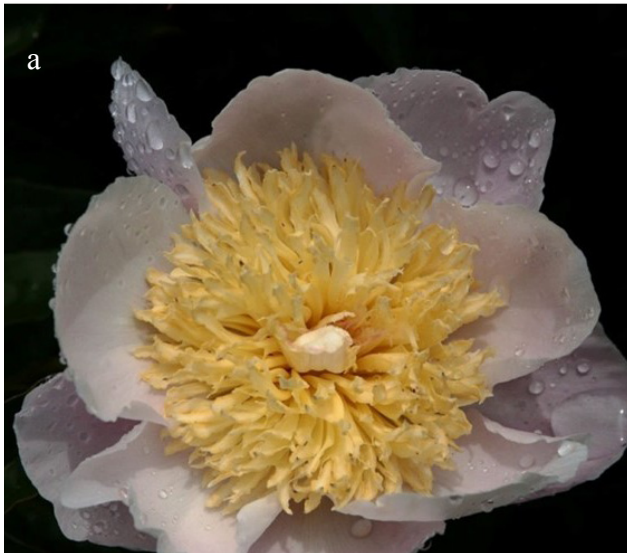
P. lactiflora Pall. 'Bu-Te'

P. lactiflora 'Philomele'

I. sibirica f. *albiflora* Makino

I. sibirica L.

H. x hybrida hort. 'Frances Williams'

H. x hybrida 'Liberty'

Figure 1. Some representatives of the genus studied in the work: a) *Paeonia*; b) *Iris*; c) *Hosta*.

The genus *Paeonia* is represented in this work by a selection of cultivars of herbaceous peony (*P. lactiflora*) with a Japanese flower shape. The selection of this garden group was carried out based on the greatest potential prospects of its representatives as components of flower compositions in urban conditions (Mironova and Reut, 2011; Pidgajnaya et al., 2015; Rudaya, 2018). The present study uses cultivars that have been in the collection of the laboratory of ornamental plants for a long time (more than 40 years) and selected as a result of many years of research work using classical techniques, that have been created for a long time, but are currently widely used in Russia (Vasil'eva, 1972; Bylov, 1978; Vasil'eva, 1980). The methodological guidelines developed by Vasilyeva M.Yu. (1972) are still the main component of the methodological base of the introduction studies of representatives of the genus *Paeonia*. And on the developed by Bylov V.N. (1978) the principles and approaches to comparative cultivar evaluation of ornamental plants are largely based on modern research work with already introduced cultivars.

Thus, the cultivar in the studied sample differ (in comparison with other cultivars of *P. lactiflora* with a Japanese flower shape from the collection of the laboratory of ornamental plants by a high level of characteristics important for plants used in landscape design. These are: 1) high stability in culture; 2) the absence of cultivation difficulties (a short non-planting period, the need to garter peduncles, etc.); 3) high intensity of flowering; 4) lack of flowering periodicity; 5) tolerance to the most common infectious diseases in central Russia (Efimov and Degtyareva, 2018; Gusev et al., 2021). The presented work uses 19 cultivars of *P. lactiflora*: 'Break o'Day', 'Bu-Te', 'Cora Stubbs', 'Fairy', 'Garden Peace', 'Gay Paree', 'Gold Standard', 'Hit Parade', 'Jan van Leeuwen', 'Lotus Queen', 'Midnight Sun', 'Moon of Nippon', 'Mrs. Wilder Bancroft', 'Neon', 'Philomele', 'Rashoomon', 'West Elkton', 'Yellow King' and 'Surprise'.

According to the method of testing herbaceous peonies for distinctness, uniformity and stability (Rogovskiy, 2003), the variability of cultivars was studied by 22 parameters. At the same time, this article highlights the results of research on three quantitative characteristics (stem length, stem thickness at the base, flower diameter), the most significant in the selection of *Paeonia* cultivars for their use on landscape architecture objects.

The genus *Hosta* is represented in this work by a sample of 23 names, including *H. undulata* L.H. Bailey, two cultivars – *H. undulata* var. *univittata* (Miq.) Hyl. and *H. undulata* var. *albomarginata* F. Maek., as well as 20 cultivars: 'August Beauty', 'Brim Cup', 'Cascade Mist', 'El Nino', 'Forest Shadows', 'Frances Williams', 'Hanky Panky', 'Illicit Affair', 'Independence', 'Inniswood', 'Julie Morss', 'June', 'Kiwi Full Monty', 'Liberty', 'Linda Sue', 'Revolution', 'Stained Glass', 'Super Nova', 'Tango' and 'Wolverine'. The representatives of the genus *Hosta* studied in this work are distinguished by a high level of a number of characteristics that should be considered when using them in landscaping. These are: 1) high stability in culture; 2) high coefficient of vegetative reproduction; 3)

significant phenotypic differences of cultivars. Literature data were used as sources of information (Aden, 1992; Grenfell and Shadrack, 2007), and the results of their own introduction studies based on the collection fund of the laboratory of ornamental plants (Bondorina et al., 2020).

To carry out a comparative analysis of the studied representatives of the genus *Hosta*, 19 quantitative characteristics were used. But this article presents the results of the work on 4 features (length and width of the leaf blade, leaf area, petiole length). These features were taken into work, as consider them to be a priority for drawing up flower beds on objects of urban landscape architecture of any category.

The genus *Iris* is represented in this study by a sample of 10 names. The choice of research objects was carried out on the basis of a comprehensive accounting of economically valuable, causing high resistance of plants in culture, and decorative features (Bylov, 1978). Thus, the methodological base is formed according to the scheme used for representatives of the genus *Paeonia*. The composition of the model sample includes: a type of natural flora – *Iris sibirica*, a garden form of natural origin – *I. sibirica* f. *albiflora* and 8 cultivars of the group Beardless irises: *I. sibirica* 'Snow Crest', *I. sibirica* 'Seven Seas', *I. sibirica* 'Skyrocket', *I. sibirica* 'Cambridge', *I. sibirica* 'Steve Warner', *I. x sibtosa* 'Bigminki Hori', *I. x sibtosa* 'Butterfly Fountain' and *I. sibirica* x *I. pseudacorus* 'Alley Oops'. These representatives of the genus *Iris* are characterized by stability in culture, high coefficient of vegetative reproduction, lack of flowering periodicity, high intensity of flowering (coefficient of ornamentation more than 0.5) and tolerance to lethal infectious diseases. It is desirable to consider the complex of these parameters in the process of selecting irises for use in urban landscaping. Sources of information are both literature data (Rahimova et al., 2020; Reut and Beksheneva, 2021; Zykova et al., 2021) and own research based on the collection of irises of the laboratory of ornamental plants. In the conditions of central Russia, *I. sibirica* is stable in culture and is characterized by a high adaptive potential. Therefore, an additional criterion for the formation of the group of cultivars studied was the selection of cultivars created using this species.

According to the methodology of testing rhizomatous irises for distinctness, uniformity and stability (Schmal', 2011), the variability of the members of the model sample was studied by 41 parameters, including 14 quantitative and 27 qualitative characteristics. This article presents the results of research on 6 quantitative characteristics (plant height; number of flowers on the peduncle; flower length; flower width; leaf blade length and leaf blade width). They are significant when choosing cultivars for their use on objects of landscape architecture.

The fixation of the coloristic characteristics of the leaf plates of the host and the elements of the iris flower was carried out using standardized color scales RHS Colour Chart. The formation of an array of digital data on a sample of representatives of the genus *Hosta* was performed using a computer program AutoCad.

Statistical processing of the obtained experimental data was carried out using the program «Statistica Base» in accordance with classical methods (Dospekhov, 1985; Zajcev, 1990).

The development of models of flower beds is based on the methods and techniques generally accepted in the design of landscape compositions (Bochkova, 2007) using the AutoCad program.

Results and Discussion

In the study, model parameters were set for representatives of the genus *Paeonia*. To recommend a cultivar for use in urban landscaping, it must have the following characteristics: the smallest stem length, the maximum stem thickness at the base and the minimum diameter of the flower. The authors consider this combination of parameters to be optimal for the cultivar recommended for flower compositions.

The variability of some quantitative characteristics of the generative sphere was studied in the studied cultivars (Table 1). At the same time, in the course of research, the dominant influence of cultivar characteristics on the variability of the morphometric characteristics under consideration was established for all the studied indicators. Also shown that the share of random factors in the structure of the overall variability of the studied features varies from 4% to 21%. Therefore, it is natural to assume that the phenotypic characteristics of plants when used in flower compositions will depend mainly on the selected variety.

Table 1. Variability of some quantitative characteristics associated with the generative phase of ontogenesis in the studied varieties of *Paeonia lactiflora*

Cultivar	Stem length (cm)			The thickness of the stem at the base (cm)			Flower diameter (cm)		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
'Philomele'	106.2	110.0	101.6	0.9	1.0	0.9	13.8	16.1	13.8
'Yellow King'	119.3	123.7	110.3	0.8	0.8	0.7	16.6	18.9	17.8
'Bu-Te'	92.8	94.1	91.6	0.7	0.7	0.8	14.3	15.0	13.9
'Midnight Sun'	95.8	100.8	91.8	0.7	0.8	1.0	16.2	16.8	14.8
'Jan van Leeuwen'	86.8	-	90.4	0.7	-	1.1	15.6	-	15.0
'Hit Parade'	115.5	120.4	124.9	0.8	0.7	0.8	14.2	17.1	16.6
'Cora Stubbs'	98.9	104.8	96.2	0.7	0.7	1.1	15.4	17.0	15.6
'Break o'Day'	-	118.4	106.4	-	0.7	1.0	-	16.1	14.4
'Rashoomon'	-	107.1	98.7	-	0.7	0.8	-	16.7	16.6
'Moon of Nippon'	100.9	98.1	89.5	0.7	1.0	0.8	15.6	17.1	15.0
'Mrs. Wilder Bancroft'	99.6	103.0	103.2	0.6	0.7	0.6	15.0	16.3	14.1
'Gay Paree'	103.7	108.6	99.2	0.7	0.7	0.6	14.6	16.2	11.5
'Gold Standard'	107.0	111.0	103.8	0.8	0.8	0.7	19.8	19.1	19.0
'Neon'	100.2	106.5	110.2	0.6	0.8	1.2	15.6	17.7	13.8
'Surprise'	103.9	105.6	101.2	0.8	0.7	0.9	18.4	18.4	17.5
'Lotus Queen'	107.7	113.6	96.9	0.8	0.9	1.1	16.3	19.0	16.8
'West Elkton'	94.6	96.3	96.1	0.8	0.7	0.7	14.0	16.5	16.9
'Fairy'	-	88.5	94.9	-	0.6	0.9	-	17.1	16.6
'Garden Peace'	-	91.6	93.6	-	0.6	0.7	-	18.8	16.5
Results of statistical processing of experimental data									
Limits	min -86.8	min -88.5	min -89.5	max - 0.9	max - 1.0	max - 1.1	min -13.8	min -15.0	min -11.5
F_f/F_{05}	27.7/2.01	27.05/1.89	18.8/1.62	7.10/2.01	20.39/1.89	50.2/1.62	14.73/2.01	12.12/1.89	49.8/1.62
Smallest significant difference$_{05}$	8.2	10.2	6.4	0.2	0.1	0.1	2.3	1.9	0.8
Sources of variation (p^{in}, %)									
factor (grade)	96	96	92	87	95	79	94	92	88
random	4	4	8	13	5	21	6	8	12

The main direction of the presented work was to identify cultivars with no reliable statistical differences with cultivars adopted by the authors as a standard.

From the presented data array (Table 1), there is no such cultivar among the studied representatives of the genus *Paeonia* according to the complex of quantitative characteristics accepted in this study as optimal.

Therefore, as standards for each of the studied characteristics, cultivars were selected that differ in low variability of data over the years of the study with the desirable absence of reliable statistical differences with cultivars that own the corresponding values of the limits.

According to the length of the stem in different years of the study, the indicators of the minimum limits belong

to three cultivars. In 2018 it is 'Jan van Leeuwen' (86.8 cm), in 2019 it is 'Fairy' (88.5 cm), in 2020 it is 'Moon of Nippon' (89.5 cm) (Table 1). At the same time, the most stable absolute indicators for this trait and the absence of significant differences at the 5% significance level with these cultivars were revealed for the cultivar 'Bu-Te'. Therefore, according to the length of the stem, this particular cultivar is used as a standard.

There is a similar trend in the thickness of the stem at the base. For three years of research, the maximum values of limits were also recorded in different cultivars: 'Philomele' – 0.9 cm (2018), 'Moon of Nippon' and 'Philomele' – 1.0 cm (2019), 'Neon' – 1.2 cm (2020) (Table 1). At the same time, it does not show significant statistical differences with them (in two out of three years of the field experiment) and differs from other members of the sample population by consistently high indicators of the 'Philomele' cultivar. Therefore, it is used as a standard according to the considered feature.

The trend of the distribution of limits on the diameter of the flower has not changed. During the three-year research cycle, their minimum values (within the study sample) were noted in several cultivars: 13.8 cm – 'Philomele' in 2018, 14.3 cm – 'Bu-Te' – in 2019 and 11.5 cm – 'Gay Paree' – in 2020 (Table 1). It should be noted that the value indicated for 'Gay Paree' is significantly lower than the indicators recorded for the other two years of the study and is explained by the negative individual reaction of the cultivar to the weather conditions of a particular growing season. At the same time, in 2020, the indicators of two cultivars by the diameter of the flower – 'Philomele' and 'Neon' (both 13.8 cm, which is the second largest absolute value of the sample) significantly exceed the 'Gay Paree' indicator at the 5% significance level. In 2019, the absence of significant differences in the considered feature was revealed between the cultivars 'Philomele' and 'Bu-Te'. Accordingly, according to the size of the flower, the most stable and close to the specified parameters, the indicators were found in the cultivar 'Philomele' used as a standard.

Thus, considering the model characteristics of *Paeonia* cultivars adopted by the authors, two cultivars were adopted as standards for the studied quantitative characteristics: 'Bu-Te' (by stem length) and 'Philomele' (by stem thickness at the base and flower diameter).

In the course of the study on the studied indicators, groups of cultivars were identified that do not have reliable statistical differences with standard cultivars. In the course of work on the studied indicators, groups of cultivars were identified that do not have reliable statistical differences with standard varieties. Along the length of the stem, there were no significant differences at the 5% significance level with the standard cultivar: 'Bu-Te'. In 2018 it was 7 cultivars 'Midnight Sun', 'Jan van Leeuwen', 'Cora Stubbs', 'Moon of Nippon', 'Mrs. Wilder Bancroft', 'Neon' and 'West Elkton'. According to 2019, there are also 7 cultivars: 'Midnight Sun', 'Cora Stubbs', 'Moon of Nippon', 'Mrs. Wilder Bancroft', 'West Elkton', 'Fairy' and 'Garden Peace'. In 2020, it is a cluster of 8 names: 'Midnight Sun', 'Jan van Leeuwen', Cora Stubbs, 'Moon

of Nippon', 'Lotus Queen', 'West Elkton', 'Fairy' and 'Garden Peace'. Thus, according to the results of three years of research, it is legitimate to single out four cultivars in the model sample – 'Midnight Sun', 'Cora Stubbs', 'Moon of Nippon' and 'West Elkton', which, according to the studied indicator, do not significantly differ from the standard cultivar 'Bu-Te'. Therefore, they can be recommended for use in landscape compositions.

The effective selection of cultivars with the absence of lodging or significant deviation of shoots from the vertical position is facilitated (as part of qualitative characteristics) by considering the type of bush, and in the complex of quantitative ones – an assessment of the linear dimensions of the generative shoot at the base.

It is shown that the type of bush in the phase of full flowering in the composition of the sample under study recorded, according to the test method of herbaceous peonies for distinctness, uniformity and stability (Rogovskiy, 2003), two gradations of the trait out of three possible. The spreading type of bush is not marked in any of the cultivars. At the same time, the distribution of cultivars according to the fixed gradations is extremely uneven. Almost all cultivars of the sample (18 out of 19 names) are characterized by a semi-spreading type of bush. The compact bush is marked only in one cultivar – 'Rashoomom'. Thus, according to the considered qualitative characteristic, the studied sample of cultivar *P. lactiflora* turned out to be homogeneous. At the same time, we note in its composition that 6 cultivars ('Bu-Te', Cora Stubbs', 'Jan van Leeuwen', 'Midnight Sun', 'Moon of Nippon', 'West Elkton') retain the shape of the bush very well. Moreover, this characteristic is realized better than other cultivars in 'Jan van Leeuwen'; somewhat worse in cultivars 'Bu-Te' and 'Midnight Sun'.

Another part of the work was the study of the variability of representatives of the genus Paeonia in the thickness of the stem at the base. For three years of the study, it was found that there were no significant differences at the 5% significance level between the majority of the members of the model sample and the cultivar 'Philomele' selected as the standard (Table 1). In 2018, only cultivar 'Mrs. Wilder Bancroft' significantly differed from the standard variety (cultivar 'Philomele'). In 2019, no significant statistical differences with the 'Philomele' variety were found in cultivars 'Moon of Nippon' and 'Lotus Queen'. In 2020, this group included 8 cultivars: 'Bu-Te', 'Midnight Sun', 'Hit Parade', 'Break o'Day', 'Rashoomon', 'Moon of Nippon', 'Fairy' and 'Surptise'. According to the data of 2020, cultivars significantly differing at the 5% level of significance from the standard were identified ('Jan van Leeuwen', 'Cora Stubbs', 'Lotus Queen' and 'Neon'). They have a greater thickness of the generative shoot at the base than the standard (cultivar 'Philomele'). These four cultivars are potentially less susceptible to lodging of peduncles.

As a result, it is legitimate to recommend cultivars 'Moon of Nippon' and 'Lotus Queen' for use in urban landscaping. But the cultivar 'Moon of Nippon' has an advantage, as it retains the shape of the bush better during flowering.

In the process of working on the size of flowers in the studied varieties and the standard (cultivar 'Bu-Te'), the absence of significant statistical differences at the 5% significance level was revealed (Table 1). For representatives of the genus *Paeonia*, the parameters of the generative sphere are important signs (Prihod'ko and Sorokopudova, 2016). According to the data obtained over 3 years of research, 11 varieties do not significantly differ in flower diameter from the standard. In 2018, these are cultivars 'Bu-Te', 'Jan van Leeuwen', 'Hit Parade', 'Cora Stubbs', 'Moon of Nippon', 'Mrs. Wilder Bancroft', 'Gay Paree', 'Neon' and 'West Elkton'. In 2019, these are cultivars 'Bu-Te', 'Midnight Sun', 'Hit Parade', 'Cora Stubbs' 'Break o'Day', 'Rashoomon', 'Moon of Nippon', 'Mrs. Wilder Bancroft', 'Gay Paree', 'Neon', 'West Elkton' and 'Fairy'. In 2020, these are cultivars 'Bu-Te', 'Break o'Day', 'Mrs. Wilder Bancroft' and 'Neon'. According to the results of the three-year research period, 3 cultivars were selected – 'Bu-Te', 'Mrs. Wilder Bancroft' and 'Neon'. We recommend them for introduction into the composition of landscape compositions in urban green areas.

As a result of the work carried out, groups of cultivars were identified in the studied representatives of the genus *Paeonia* for each of the three quantitative characteristics studied, which do not significantly differ from cultivars taken as standards. According to the length of the stem, these are cultivars 'Midnight Sun', 'Cora Stubbs', 'Moon of Nippon' and 'West Elkton' (standard - cultivar 'Bu-Te'); by the thickness of the stem at the base, these are cultivars 'Moon of Nippon' and 'Lotus Queen' (standard - cultivar 'Philomele'); by the diameter of the flower these are cultivars 'Bu-Te', 'Mrs. Wilder Bancroft' and

'Neon' (standard - cultivar 'Bu-Te'). At the same time, full compliance with the model parameters set in the work was not found in any of the cultivars. Therefore, for use in flower arrangements, we recommend cultivators that combine the greatest number of necessary characteristics. According to the length of the stem and the diameter of the flower, a cultivar 'Bu-Te' can be distinguished. According to the length of the stem and its thickness at the base, a cultivar 'Moon of Nippon' can be distinguished. In addition, the cultivar 'Bu-Te' is characterized by a compact form of the bush, which is well preserved during the flowering phase. Therefore, the optimal combination of features of the generative sphere, we allocate cultivar 'Bu-Te' and we recommend it for use in urban green areas.

For representatives of the genus *Hosta*, a slightly different approach is applied. In the study, a slightly different approach was used for representatives of the genus Hosta. In order to recommend a cultivar for use in urban landscaping, it must have the maximum indicators for the selected characteristics: the largest linear sizes of leaves, the maximum area of leaf blades and the largest petiole length.

The main focus of the work was the selection of cultivars of the genus *Hosta*, which have no reliable statistical differences with the variety adopted as a standard.

In the course of the study, the variability of four quantitative characteristics of the vegetative sphere in 23 representatives of the genus *Hosta* was studied (Table 2). According to the results of statistical processing of the data obtained, the influence dominates for all the studied indicators, the share of the influence of random factors is small (15%-21%).

Table 2. Variability of quantitative characteristics of leaf in the studied cultivars of the genus *Hosta* (2020)

Cultivar	Petiole length (cm)	Sheet length (cm)	Sheet width (cm)	Sheet area (mm²)
H. undulata	22.3	13.7	5.6	51.6
H. undulata var. *albomarginata*	28.0	21.9	10.5	167.9
H. undulata var. *univittata*	23.9	13.8	7.0	72.2
H. x hybrida 'August Beauty'	35.6	19.7	17.8	266.3
H. x hybrida 'Brim Cup'	17.8	11.9	9.6	84.7
H. x hybrida 'Cascade Mist'	19.3	8.0	17.1	113.7
H. x hybrida 'El Nino'	23.4	14.6	7.1	71.8
H. x hybrida 'Forest Shadows'	23.6	18.5	9.6	116.9
H. x hybrida 'Frances Williams'	26.3	22.4	16.8	260.3
H. x hybrida 'Hanky Panky'	21.5	10.1	4.5	31.2
H. x hybrida 'Illicit Affair'	24.1	7.2	6.2	30.2
H. x hybrida 'Independence'	26.4	18.1	13.2	171.9
H. x hybrida 'Inniswood'	26.5	11.5	8.5	76.0
H. x hybrida 'Julie Morss'	34.0	20.6	13.4	203.1
H. x hybrida 'June'	29.0	9.3	4.3	27.2
H. x hybrida 'Kiwi Full Monty'	30.9	13.5	10.9	129.5
H. x hybrida 'Liberty'	20.9	23.1	16.5	274.6
H. x hybrida 'Linda Sue'	24.2	17.7	13.0	172.4
H. x hybrida 'Revolution'	15.8	15.1	10.6	109.7
H. x hybrida 'Stained Glass'	23.9	19.6	13.1	190.5
H. x hybrida 'Super Nova'	36.6	21.5	15.0	240.8
H. x hybrida 'Tango'	29.7	13.1	9.7	93.3
H. x hybrida 'Wolverine'	25.5	14.5	7.2	66.6
Results of statistical processing of experimental data				
Limits	max – 36.6	max – 23.1	max – 17.8	max – 274.6
F_f/F_{05}	103.245/1.56	62.663/1.58	71.672/1.58	48.577/1.58
Smallest significant difference$_{05}$	1.80	1.75	1.29	29.65
Sources of variation (p^{in}, %)				
factor (genotype)	82	85	85	79
random	18	15	15	21

When studying such an indicator as the length of the petiole, it was revealed that there were no significant differences at the 5% significance level only between the cultivar with the maximum limit ('Super Nova' - 36.6 cm) and the cultivar 'August Beauty' (35.6 cm) (Table 2).

A three-component complex of quantitative characteristics of a leaf blade (length, width and area) has also been studied. It is of great importance when selecting hosts for use in compositions in urban green areas.

The maximum limit on the length of the leaf blade belongs to the Liberty cultivar' (23.1 cm). Three cultivars have no significant differences at the 5% significance level with this cultivar – *H. undulata* var. *albomarginata* (21.9 cm), 'Frances Williams' (22.4 cm) and 'Super Nova' (21.5 cm).

According to the width of the leaf blade, the maximum indicator belongs to the cultivar 'August Beauty' (17.8 cm). Cultivars 'Cascade Mist' (17.1 cm), 'Frances Williams' (16.8 cm) and 'Liberty' (16.5 cm) do not differ significantly from it.

According to the leaf area, the maximum limit is set for the cultivar 'Liberty' (274,6 mm²). The cultivars 'August Beauty' (266.3 mm²) and 'Frances Williams' (260.3 mm²) did not have significant statistical differences at the 5% significance level (Table 2).

In this sample, no cultivars were identified, according to the totality of the 4 studied traits, which have significant differences with varieties with maximum limits. However, based on the characteristics associated with the parameters of the leaf blade (length, width and leaf area), it is legitimate to distinguish 2 cultivars - 'Frances Williams' and 'Liberty', characterized by the absence of significant differences with the cultivars ('Liberty' and 'August Beauty'), which belong to the corresponding indicators of limits.

Studies of representatives of the genus *Iris* were carried out according to an identical scheme with a representative of the genus *Hosta*. As an optimal combination of features, the following characteristics are accepted: the highest height of the plant, the maximum number of flowers on the peduncle, the minimum linear dimensions of the flower, the largest linear dimensions of leaf blades. The study, depending on the studied trait, was focused on the maximum or minimum indicators of limits.

According to the results of the conducted studies, the influence of genotype dominates in all samples, and the proportion of random factors is insignificant and ranges from 5% to 11% (Table 3). It is legitimate to expect that the phenotypic characteristics of plants when they are used as part of flower compositions will depend, first of all, on the selected cultivar.

Table 3. Variability of morphological characteristics in the studied representatives of the group Beardless irises (2021)

Cultivar	Plant height (cm)	The number of flowers on the peduncle, pc.	Flower length (cm)	Flower width (cm)	Sheet length (cm)	Sheet width (cm)
I. sibirica	136.6	4	6.5	6.9	76.7	0.8
I. sibirica f. *albiflora*	98.5	7	6.4	5.5	73.1	0.7
I. sibirica 'Snow Crest'	81.5	2	8.5	8.5	59.3	0.9
I. sibirica 'Seven Seas'	95.0	3	9.5	9.4	73.1	1.0
I. sibirica 'Skyrocket'	75.6	2	8.9	10.0	60.1	0.9
I. sibirica 'Cambridge'	74.0	2	5.9	9.4	75.0	1.1
I. sibirica 'Steve Warner'	81.9	3	5.5	5.8	75.0	1.1
I. x sibtosa 'Bigminki Hori'	79.7	3	5.7	6.1	80.3	0.9
I. x sibtosa 'Butterfly Fountain'	76.8	6	4.0	6.2	-	-
I. sibirica x I. pseudacorus 'Alley Oops'	87.7	4	6.2	8.7	88.1	1.4
Results of statistical processing of experimental data						
Limits	max - 136.6	max - 7	min - 4.0	min - 5.5	max - 88.1	max - 1.4
F_f/F_{05}	302.8/1.99	311.8/1.99	307.0/1.99	182.5/1.99	24.1/2.65	42.2/2.65
Smallest significant difference$_{05}$	4.8	0.5	0.34	0.35	5.98	0.06
Sources of variation (p^{in}, %)						
Factor (genotype)	93	91	94	89	92	95
Random	7	9	6	11	8	5

Focusing on the accepted model parameters, groups of cultivars were identified, which are characterized by the absence of reliable statistical differences with the images to which the values of the limits (maximum or minimum) belong according to the corresponding characteristics.

In terms of plant height, the maximum limit belongs to the cultivar *I. sibirica* (136.6 cm). There are no significant differences with it. At the same time, the absence of reliable differences was noted between the natural form of *I. sibirica f. albiflora* and the cultivar 'Seven Seas' (Table 3).

According to the number of flowers, the maximum limit belongs to *I. sibirica* f. *alba* (7 pc.). It is established that all other studied representatives of the genus *Iris* have insignificant differences. At the same time, the highest absolute value was recorded in the cultivar 'Butterfly Fountain' (6 pc.) (Table 3).

According to the parameters of the flower, the studied representatives of the genus Iris also showed no significant differences. The minimum values for the length of the flower belong to the cultivar 'Butterfly Fountain' (4.0 cm). Cultivars with no significant differences with it were not identified. The lowest values with the presence of reliable statistical differences with 'Butterfly Fountain' were recorded in cultivars 'Bigminki Hori' (5.7 cm), 'Steve Warner' (5.5 cm) and 'Cambridge' (5.9 cm).

According to the width of the flower, the minimum limit belongs to *I. sibirica* f. *albiflora* (5.5 cm). The absence of significant differences with it was established with the cultivar 'Steve Warner' (5.8 cm) (Table 3).

Irises are beautifully blooming plants. But many representatives of the group of Beardless irises have a dense curtin, which persists throughout the growing season. They remain decorative for a long time. This allows them to be used in landscape compositions (Stepanova, 1991; Dolganova, 2016; Kryukova and Abramova, 2021). Therefore, within the framework of the work, the variability of quantitative characteristics of the vegetative sphere of the group Beardless irises was studied.

According to the length of the leaf' the maximum limit value belongs to the cultivar 'Alley Oops' (88.1 cm). There were no significant differences with it. At the same time, the largest absolute value with the presence of significant differences was noted in the cultivar 'Bigminki Hori' (80.3 cm).

According to the width of the leaf, the maximum value of the limit belongs to the cultivar 'Alley Oops' (1.4 cm). There were no samples without significant differences with it. The highest value of this feature (1.1 cm) was recorded for cultivars 'Cambridge' (1.1 cm) and 'Steve Warner' (1.1 cm) (Table 3).

Thus, as part of the model sample of representatives of the genus *Iris* names studied in the framework of this work, according to a set of 6 studied quantitative signs that do not have reliable statistical differences at a 5% significance level with samples characterized by maximum or minimum values of limits were not revealed.

Two representatives of the genus *Iris* ('Steve Warner' and *I. sibirica* f. *albiflora*) may be recommended for use as part of landscape compositions at urban public facilities.

As a result, carried out on the basis of the results of a three-year cycle of studying the variability of a number of quantitative characteristics of representatives of 3 ornamental crops in the design of landscape compositions for urban public areas, it is legitimate to recommend the following names: representatives of the genus *Paeonia* - cultivar 'Bu-Te', *Hosta* - 2 cultivars: 'Frances Williams' and 'Liberty', *Iris* has *I. sibirica* f. *albiflora* a garden form of natural origin.

Using the AutoCAD program schemes of three variants of flower beds were developed for urban landscaping of urbanized territories using the above-listed representatives of the genera *Paeonia, Hosta* and *Iris* (Figure 2-4).
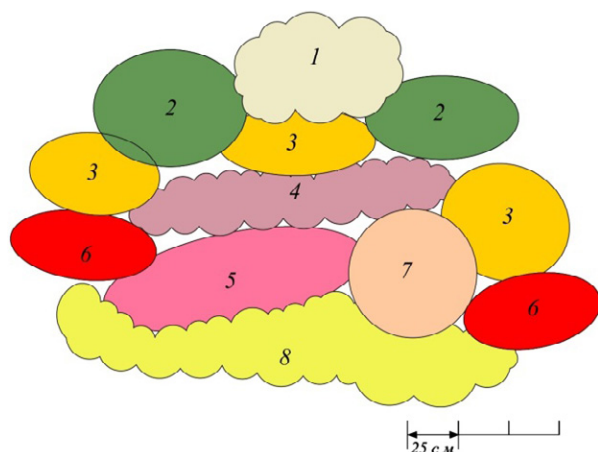
1 – *Iris sibirica* L. f. *albiflora*
2 – *Hosta x hybrida* hort. 'Frances Williams'
3 – *Hemerocallis x hybrida* hort. 'Mary Todd'
4 – *Allium aflatunense* B. Fedtsch.
5 – *Astilbe x arendsii* hort. 'Sister Theresa'
6 – *Geum chiloense* Balb. ex Ser.
7 – *Paeonia lactiflora* Pall. 'Bu-Te'
8 – *Alchemilla mollis* (Bus) Rothm.
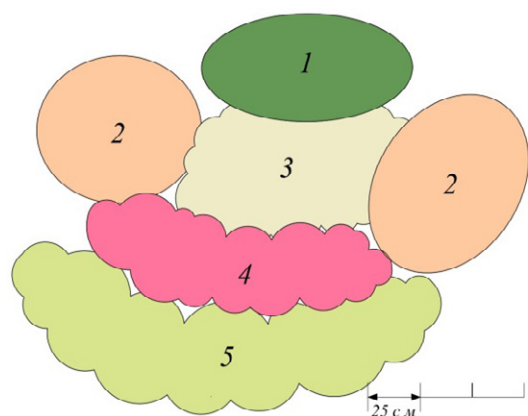
Figure 2. A variant of the flower arrangement №1

1 – *Hosta x hybrida* hort. 'Frances Williams'
2 – *Paeonia lactiflora* Pall. 'Bu-Te'
3 – *Iris sibirica* L. f. *albiflora*
4 – *Astilbe x arendsii* hort. 'Flamingo'
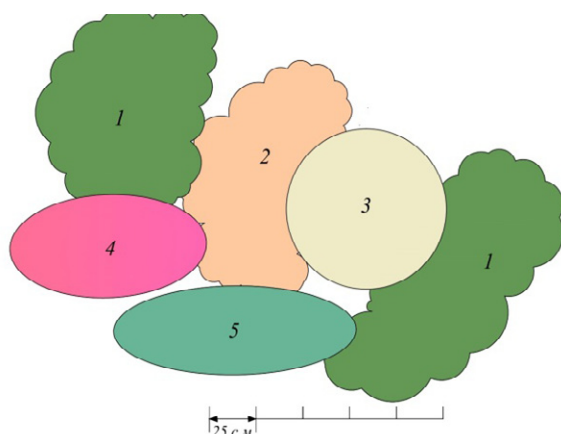5 – *Geranium x cantabrigense*

Figure 3. A variant of the flower arrangement №2

1 – *Hosta x hybrida* hort. 'Frances Williams'
2 – *Paeonia lactiflora* Pall. 'Bu-Te'
3 – *Iris sibirica* L. f. *albiflora*
4 – *Geranium sanguineum* L. 'Nana'
5 – *Brunnera macrophylla* (Adam.) Johnst
'Jack Frost'

Figure 4. A variant of the flower arrangement №3

Conclusions

It was found that for the studied representatives of three ornamental crops - *Paeonia*, *Hosta* and *Iris* - the influence of genetic features (species or varietal) dominates in the structure of their overall variability for all the morphometric characteristics studied, and the proportion of random factors is generally insignificant. Therefore, it is legitimate to assume that the phenotypic characteristics of plants when used in flower compositions will depend mainly on the chosen name.

It was revealed that from the composition of model sample aggregates based on a comparative assessment of the variability of a number of quantitative characteristics, the following should be considered potentially promising for use in the design of flower compositions for urban landscaping facilities: representatives of the genus *Paeonia* - the cultivar 'Bu-Te', *Hosta* - cultivars 'Frances Williams' and 'Liberty', *Iris* - garden form of natural origin I. *sibirica* f. *albiflora*.

Using the names of peonies, hostas and irises selected based on the results of a comparative study of their biometric characteristics, three variants of flower compositions have been developed, oriented to placement on public urban landscaping facilities.

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