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DECORATIVE QUALITIES OF SUBTROPICAL FRUIT PLANTS IN LANDSCAPEING OF POPULATED SETTLEMENTS OF THE FOREST-STEPPE OF UKRAINE

Actuality. The positive results of the introduction of certain subtropical species in the forest-steppe zone of Ukraine are becoming very relevant in terms of their distribution in populated settlements as fruit-bearing polycarpic plants. At the same time, subtropical plants amaze with the unusual shape of leaves, flowers, fruits, etc. Such their unusualness should be properly appreciated as a source of positive emotions, and the plants themselves should be used in decorative gardening.

The purpose of the work is evaluation of the decorative qualities of subtropical fruit plants of the collection of the Khorolskyi Botanical Garden, suitable for landscaping the settlements of the forest-steppe of Ukraine.

Research materials and methods. The research material was subtropical species of polycarpic fruit plants such as *A. triloba*, *M. germanica*, *P. dulcis*, *F. carica*, *P. granatum*, *D. virginiana* introduced in the Khorolskyi Botanical Garden. The subject of research is decorative qualities of plants. The point integral scale of the comprehensive assessment of woody decorative exotic plants based on the main morphological features has been used.

Research results and their discussion. On the basis of the biomorphological characteristics of the studied subtropical species, the corresponding indicators of the general decorativeness of plants, decorativeness of the bark, leaves, and generative organs have been calculated on a 5-point scale, and the total score of decorativeness has been calculated from the sum of the indicators. The group of decorativeness has been determined by the total number of points.

Priority is given to the biomorphological characteristics of plants, winter resistance, fruiting, biochemical composition of raw materials, and their processing in scientific publications. At the same time, there are no studies on the decorativeness of the species.

Conclusions. *D. virginiana* has the highest rate of decorativeness, *M. germanica*, *A. triloba*, *F. carica*, *P. dulcis*, *P. granatum* have a slightly lower rate of decorativeness. The conducted research allows us to popularize and use these species not only as fruit and medicinal plants, but also as decorative ones, that is, they can perform another, quite important function – to evoke positive emotions.

Key words: subtropical fruit plants, the Forest-Steppe of Ukraine, decorative qualities.

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ДЕКОРАТИВНІ ЯКОСТІ СУБТРОПІЧНИХ ПЛОДОВИХ РОСЛИН В ОЗЕЛЕНЕННІ НАСЕЛЕНИХ ПУНКТІВ ЛІСОСТЕПУ УКРАЇНИ

Актуальність. Позитивні результати інтродукції окремих субтропічних видів у лісостеповій зоні України набувають неабиякої актуальності щодо поширення в населених пунктах як плодкових полікарпічних рослин. Водночас субтропічні рослини викликають подив незвичайною формою листків, квіток, плодів тощо. Така їх незвичайність має бути належно оцінена як джерело позитивних емоцій, а самі рослини – використовуватись у декоративному садівництві.

Мета роботи – оцінити декоративні якості субтропічних плодкових рослин колекції Хорольського ботанічного саду, придатних для озеленення населених пунктів лісостепу України.

Матеріали та методи дослідження. Матеріалом для досліджень були інтродуковані в Хорольському ботанічному саду субтропічні види полікарпічних плодкових рослин: *A. triloba*, *M. germanica*, *P. dulcis*, *F. carica*, *P. granatum*, *D. virginiana*. Предметом дослідження є декоративні якості рослин. Використано бальну інтегральну шкалу комплексної оцінки деревних декоративних екзотичних рослин за основними морфологічними ознаками.

Результати дослідження та їх обговорення. На основі біоморфологічної характеристики досліджуваних субтропічних видів обраховано за 5-бальною оцінкою відповідні показники загальної декоративності рослин, декоративності кори, листків, генеративних органів, вираховано за сумою показників загальний бал декоративності. Групу декоративності визначали за загальною кількістю балів.

У наукових публікаціях віддається перевага біоморфологічній характеристиці рослин, зимостійкості, плодоношенню, біохімічному складу сировини, її переробці. Водночас відсутні дослідження щодо декоративності видів.

Висновки. Найвищий показник декоративності має *D. virginiana*, децю менший – *M. germanica*, *A. triloba*, *F. carica*, *P. dulcis*, *P. granatum*. Проведене дослідження дає змогу популяризувати та використовувати ці види не лише як плодів та лікарські рослини, а і як декоративні, тобто вони можуть виконувати й іншу, досить важливу функцію – викликати позитивні емоції.

Ключові слова: субтропічні плодкові рослини, лісостеп України, декоративні якості.

Introduction. Actuality. In Ukraine, as in other countries, the functional zoning of settlements has been closely related to tree plantations for many centuries. And this is justified by time because tree plantations have a direct

impact on the thermal regime, wind speed, humidity and air composition, regulation of rain flows. In addition, woody plants protect people from the heat and improve physical and mental health, and are a habitat for birds and insects.

In gardens and parks, alleys and other plantings, woody and shrubby plants perform the function of three-dimensional compositions. Their decorativeness is manifested in the external features of plants, namely, the shape and size of the crown, the color of leaves, flowers, fruits, etc.

The decorative qualities of various groups of plants have long attracted people, and taking into account that such features are characteristic of many tree and fruit species, they are also used in landscaping. Among them, the most common genera are the following: *Prunus* L., *Cerasus* Juss., *Malus* Mill., *Pyrus* L., *Crataegus* L., *Amygdalus* L., *Juglans* L., *Sorbus* L., *Viburnum* L.

Due to the modern anthropogenic impact on the environment, the problem of optimizing the existing green areas of settlements and creating new ones becomes especially relevant. The most effective means in this case is introduction of introduced woody ornamental plants with valuable economic and biological characteristics into landscaping because among them there is a great variety of shapes, colors and textures that creates unlimited opportunities for improving architectural and artistic appearance of the landscape.

Due to climate changes, it is worth paying more attention to the introduction of introduced species into the landscaping of the forest-steppe zone of Ukraine as fruit crops, subtropical woody fruit plants. They are durable, drought-resistant, heat-resistant, resistant to pests and diseases and have decorative qualities peculiar only to them that have not been described so far.

The purpose of the work – evaluation of the decorative qualities of subtropical fruit plants of the collection of the Khorolskyi Botanical Garden, suitable for landscaping settlements of the forest-steppe of Ukraine.

Research materials and methods. The study was carried out in the framework of the search for complex economic use of subtropical fruit plants introduced in the forest-steppe zone of Ukraine (*Asimina triloba* (L.) Dunal, *Mespilus germanica* L., *Prunus dulcis* (Mill.) D.A.Webb, *Ficus carica* L., *Punica granatum* L., *Diospyros virginiana* L.), which are cultivated in the Khorolskyi Botanical Garden (hereinafter KhBG) and form the basis of the collection area of the “Garden of Subtropical Fruit Crops” of the scientific zone of the institution.

An integral scale for the comprehensive assessment of species of decorative exotic woody plants based on the main morphological features (on a 5-point scale) that is also optimized for deciduous trees and shrubs is used in the research. The evaluation of decorative features is proposed to be carried out according to four main blocks. The first block is an assessment of general decorativeness of plants that includes the period of decorativeness, decorative features of the crown (shape, density, texture), duration of flowering and foliage. The second block is an assessment of decorativeness of the bark, its texture and color. The third one is an assessment of decorativeness of leaves in terms of shape, size, color and seasonality of its changes. The fourth one is an assessment of decorativeness of generative organs of the plant that is based on size, color, abundance of flowers, inflorescences, as well as shape, size, color, and abundance of fruits. Indicators of plant winter resistance, frost resistance, drought resistance, and heat resistance are deliberately not included in the scale because this is an internal eco-typical ability of plants to resist a complex of adverse environmental influences (Vlasenko, 2016, pp. 27–35).

Degrees of assessment of the decorativeness of trees and shrubs are calculated according to table 1.

The study of changes in the phases of plant development, including photofixation of leaves, flowers and fruits, was carried out in the KhBG during 2018–2023.

Research results and their discussion. Being valuable in terms of food and medicine, subtropical polycarpic fruit plants, introduced in the forest-steppe zone of Ukraine, play a leading role in healthy human nutrition and phytotherapy (Krasovskyi et al., 2022; Krasovskyi et al., 2023). An important factor in the expediency of the spread of new species is also their decorative and aesthetic characteristics, which affect the emotional perception of people unusual for the forest-steppe plants.

Based on our own visual observations of the development of subtropical species such as *A. triloba*, *M. germanica*, *P. dulcis*, *F. carica*, *P. granatum*, *D. virginiana* in the KhBG, we present their biomorphological characteristics.

A. triloba is a deciduous tree, 3–4 m tall in vitro, up to 10 m in natural conditions. The shape of the crown is

Table 1

Degrees of assessment of decorativeness of trees and shrubs

Degree of decorativeness, points	13–40	41–50	51–64	65–90
		decorativeness is low	decorativeness is middle	decorativeness is high
Decorative group	IV	III	II	I

pyramidal, it is broadly pyramidal at maturity. Perennial branches are thin, fragile, branching is sympodial. The most common form of the leaf blades is obovate, less often oblong. The leaves are simple without stipules, entire, leaf veins are pinnate, the petiole is short – up to 1 cm. The length of leaf blades is up to 35 cm, the width is up to 10 cm. The color of leaves is dark green. Flowers develop from generative buds that are laid in the axils of the leaves. The peduncle is 1–3 cm long, covered with brown hairs, three lobes of the calyx are ovate, sharp, pale green outside, pubescent. Six dark burgundy, broad-ovate, bluntly pointed petals with mesh veins are arranged in two circles with bent petals. Flowers have several carpels each, which explains the property of one flower to form several fruits. The fruit is light green, cylindrical (fig. 1).



Fig. 1. *A. triloba*

1 – leaves, 2 – flower, 3 – fruits

M. germanica is a tree or bush up to 5 m tall, has a thick crown, branches have thorns, but they are absent in some cultivated forms and varieties. The leaves are alternate, elliptical or lanceolate, up to 12 cm long, up to 5 cm wide. The flowers are regular, bisexual, five-petaled, white, large, 3–5 cm in diameter, numerous, placed 1–2 pieces on the tops of shortened shoots. Bracts are pale green, large, falling. Sepals are longer than petals, lanceolate. The fruit is a spherical apple, brownish in color, up to 4 cm in diameter, with a wide-open sepal depression surrounded by long sepals. The fruits remain on the branches until February–March of the following year (fig. 2).



Fig. 2. *M. germanica*

1 – leaves, 2 – flowering, 3 – fruit

P. dulcis is a deciduous tree up to 6 m tall or a branchy bush up to 3 m tall. The bark of the branches of young trees is smooth, gray in color, covered with lenticels. Annual shoots have smooth, gray-green bark, often with an anthocyanin tint on the light side. The leaves are

oblong-lanceolate, whole with falling stipules, the edges of the leaves are serrated. The leaves are light to dark green in color. Flowers have five pubescent sepals and a bell-shaped calyx. Five petals are mostly white, rarely pink. The fruit is a drupe with a dry carpel that splits into two leaflets after maturity. The kernel is smooth, mesh-grooved, or perforated, separated from the pericarp, with a thick hard or fragile cover (shell) (fig. 3).



Fig. 3. *P. dulcis*

1 – leaves, 2 – flowering, 3 – fruits

F. carica is dioecious subtropical deciduous fruit plant, grows as a tree with a spreading crown up to 12 m in height, but under unfavorable conditions it can take the form of a multi-stemmed tree or bush. In the conditions of KhBG, it is cultivated as a covering bush for the winter up to 1.5 m high. The bark of the branches is light gray, smooth. The leaves are alternate, long-stalked, leaf blades up to 25 cm long and up to 30 cm wide, three- and five-lobed. Fruits of *F. carica* are achenes, which are in the cotyledon. The shape of the fruit is mostly pear-shaped (fig. 4).

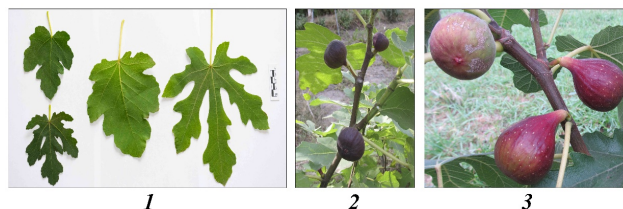


Fig. 4. *F. carica*

1 – leaves, 2–3 – fruits

P. granatum is a branched tree or bush 3–5 m tall. The branches are angular with thorns. In the conditions of KhBG, it is cultivated as a covering bush for the winter up to 1.3 m high. One-year shortened shoots end with a sharp spike. At the beginning of their development, the branches are green, with time they turn gray. The bark of the branches cracks as it ages and acquires a darker color. The leaves are simple, opposite or collected in bunches, oblong-lanceolate, bare on top, dark green, shiny, light green on the bottom. The bright red flowers are up to 4 cm large, single or in bunches at the ends of the shoots, bisexual, with columns of different lengths: flowers with short columns function as male, flowers with long columns function as female, fruit-bearing. The calyx is thick, 5–6-lobed, dark red, leathery, and remains

on the top of the fruit (fig. 5). The fruit is a pomegranate with a dark red leathery fruit, a long, drooping peduncle and a calyx that does not fall off. It bears fruit in 2022 in KhBG, at the moment the fruits have not yet acquired full size and ripeness.



Fig. 5. *P. granatum*

1 – leaves, 2 – budding, 3 – flower

D. virginiana is a tree up to 20 m tall, in vitro up to 4 m. The plant is dioecious. The shape of the crown is from rounded to sprawling, the trunk is thick, the branches are sometimes drooping. Young shoots have smooth light gray, sometimes pubescent bark. Perennial branches are gray with cracking bark. The leaves are simple, petiolate, solid, lanceolate, elongated, oval. The leaf blade is dark green on top, shiny, light green on the bottom, slightly pubescent. The color of the flowers is from yellow-green to white. Male and female flowers of the plant are located on the shoots of the current year's growth. Female flowers are large, single, male flowers are small, contained in three- to five-flowered inflorescences. The corolla of stamen flowers has grown more than half, bell-shaped, the corolla of pistillate flowers has grown to half its length. The free ends of the petals of pistillate flowers are bent, straight, thick, waxy, barely pubescent, there are four of them. The fruit is a conical or spherical berry up to 5 cm in diameter (fig. 6).



Fig. 6. *D. virginiana*

1 – leaves, 2 – flowers ♂, 3 – flower ♀, 4 – fruits

Based on the biomorphological characteristics of the studied subtropical species, the corresponding indicators of the overall decorativeness of plants, decorativeness of the bark, leaves, and generative organs have been calculated on a 5-point scale, the total score of decorativeness has been calculated from the sum of the indicators, and the decorativeness group of plants has been calculated based on the degree of decorativeness of trees and shrubs (table 2).

Currently, landscape compositions are created in Poltava (Bairak et al., 2007; Derevianko et al., 2017) as in other settlements of the forest-steppe zone of Ukraine, and they represent dendroflora of different geographical

Table 2

Evaluation of decorativeness of subtropical species

Species	General decorativeness of the plant, (points)						Decorativeness of the bark, (points)		Decorativeness leaves, (points)				Decorativeness of generative organs, (points)						Total score	Decorativeness group	
	time of decorativeness		crown		duration		texture	color	dimensions	form	color	color change	flowers / inflorescences			fruits (cones)					
	form	density	texture	flowering (pollination)	Foliage	dimensions							color	abundance	form	dimensions	color	abundance			
A. triloba	3	5	3	3	5	1	3	3	5	5	5	3	3	5	0	5	5	3	0	65	I
M. germanica	3	5	5	3	3	5	3	3	3	3	3	3	1	5	5	5	3	5	5	71	I
P. dulcis	3	3	1	3	3	3	3	3	3	1	3	1	1	5	3	1	3	1	1	45	III
F. carica	3	3	5	3		5	5	3	5	5	3	1				5	3	5	5	59	II
P. granatum	3	3	5	3	5	3	3	1	1	1	3	3	1	5	3					43	III
D. virginiana	3	5	5	3	5	1	5	5	3	5	3	3	1	5	5	5	3	5	5	75	I

zones, excluding introduced subtropical fruit species such as *A. triloba*, *M. germanica*, *P. dulcis*, *F. carica*, *P. granatum*, *D. virginiana*. This is most likely due to their comprehensive research on winter hardiness and fruiting (Klymenko et al., 2012), changes in the life form of plants (*F. carica*, *P. granatum*) and cultivation under conditions of introduction as cover crops (Krasovskyi et al., 2022; Krasovskyi, 2014). Considering the fact that the fruits of *A. triloba* have a short shelf life, the potential of their preservation by freezing has been studied (Adainoo et al., 2022). The biochemical composition of *M. germanica* fruits (Voaides et al., 2021), the change in their quality indicators after heat treatment (Mikulic-Petkovsek et al., 2023), and nutritional composition of fruits (Nistor et al., 2024) have been studied. The chemical composition of the core of *P. dulcis* (Massantini et al., 2022) and health-enhancing compounds (Barreca et al., 2020) have been studied, beneficial properties of the shell (Garcia-Perez et al., 2021), and economic evaluation and innovativeness of almond orchards (Sottile et al., 2020) have been studied. The leaves of *F. carica* have been studied as a source of bioactive compounds (Shiraishi et al., 2023), bud differentiation and flower morphology of various varieties of *P. granatum* (Ferrara et al., 2023) have been studied.

Research on the decorative qualities of subtropical fruit plants was not conducted primarily due to their low distribution in the Forest-Steppe of Ukraine, insufficient popularization as fruit, medicinal and decorative plants. At the same time, they deserve complex use because they are drought-resistant, in the conditions of introduction they are not affected by pests and diseases, and they do not belong to invasive species. Fruits, flowers, and leaves are significantly different from woody fruit plants that are traditionally used in the landscaping of settlements in the Forest-Steppe of Ukraine.

Conclusions. Based on information about the morphological structure of subtropical species such as *A. triloba*, *M. germanica*, *P. dulcis*, *F. carica*, *P. granatum*, *D. virginiana*, growing in the conditions of the Khorolskyi Botanical Garden, the decorative qualities of the plants have been determined. *D. virginiana* has the highest rate of decorativeness, the following in descending order of decorativeness are: *M. germanica*, *A. triloba*, *F. carica*, *P. dulcis*, *P. granatum*. The conducted research allows us to popularize and use these species not only as fruit and medicinal plants, but also as decorative ones, that is, they can perform another, quite important function - to evoke positive emotions, affecting psychological state of people.

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