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FEATURES OF THE INTRODUCTION AND USE OF CATALPA SPECIES IN LANDSCAPING IN THE CONDITIONS OF THE BOTANICAL GARDEN «PODILLIA» OF VNAU

Greening is a key element of the city's planning structure, it does not only create comfortable conditions for living and recreation, but also has a beneficial effect on the health of the population. Proper landscaping of territories is of great importance, as it reduces the negative impact of the environment on humans.
The article examines the biological, ecological and decorative features of introduced species of the genus Catalpa in urban conditions of Podillia and justifies the directions of their use in landscaping the botanical garden «Podillia» of VNAU. The purpose of the work is to assess the adaptability and phenological rhythm of C. bignonioides and C. speciosa and determine their practical suitability for different types of plantings. The study was carried out in 2024-2025 as a field experiment with randomized placement of variants on plots with equal soil and microclimatic conditions, regular phenoobservations, morphometry and visual-score assessment of decorativeness are provided. It was found that C. speciosa enters the spring phases earlier and has a more intensive initial growth and more pronounced early summer flowering, while C. bignonioides retains leaves longer in autumn, providing a late-season green accent, fruit ripening in both species occurs almost synchronously at the end of October. The feasibility of differentiated use of species is shown: C. speciosa - for parade axes, alleys and early summer accents, C. bignonioides - for continued seasonal decorativeness and the formation of silhouette compositions. Practical recommendations cover requirements for the place of growth, formative pruning and integration of Catalpa into urban green corridors as a dust-collecting and microclimatic element. The results obtained expand the range of resistant introducers for urbanized landscapes of Podillia and serve as a methodological guideline for municipal landscaping of the region.
Key words: *Catalpa bignonioides, Catalpa speciosa, introduction, decorativeness, landscaping, botanical garden.*

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ОСОБЛИВОСТІ ІНТРОДУКЦІЇ ТА ВИКОРИСТАННЯ В ОЗЕЛЕНЕННІ ВИДІВ РОДУ КАТАЛЬПА (CATALPA) В УМОВАХ БОТАНІЧНОГО САДУ «ПОДІЛЛЯ» ВНАУ

Озеленення є ключовим елементом планувальної структури міста, воно не лише формує комфортні умови для проживання й відпочинку, а й сприятливо позначається на здоров'ї населення. Належний благоустрій територій має істотне значення, оскільки зменшує негативний вплив довкілля на людину.

У статті розглянуто біолого-екологічні та декоративні особливості інтродукованих видів роду Catalpa у міських умовах Поділля та обґрунтовано напрями їх використання в озелененні ботанічного саду «Поділля» ВНАУ. Мета роботи – оцінити адаптивність і фенологічний ритм C. bignonioides і C. speciosa та визначити їх практичну придатність для різних типів насаджень. Дослідження виконано у 2024-2025 рр. як польовий експеримент із рандомізованим розміщенням варіантів на ділянках із вирівняними ґрунтовими та мікрокліматичними умовами, проведено регулярні феноспостереження, морфометрію та візуально-бальне оцінювання декоративності. Встановлено, що C. speciosa раніше входить у весняні фази та має інтенсивніший стартовий ріст і виразніше ранньолітнє цвітіння, тоді як C. bignonioides довше утримує листя восени, забезпечуючи пізньосезонний зелений акцент, дозрівання плодів у обох видів відбувається майже синхронно наприкінці жовтня. Показано доцільність диференційованого застосування видів: C. speciosa – для парадних осей, алей і ранньолітніх акцентів, C. bignonioides – для продовження сезонної декоративності та формування силуетних композицій. Практичні рекомендації охоплюють вимоги до місця зростання, формувальне обрізування та інтеграцію катальпи в міські зелені коридори як пиловловлювального й мікрокліматичного елемента. Отримані результати розширюють асортимент стійких інтродуцентів для урбанізованих ландшафтів Поділля та слугують методичним орієнтиром для муніципального озеленення регіону.

Ключові слова: *Catalpa bignonioides, Catalpa speciosa, інтродукція, декоративність, озеленення, ботанічний сад.*

Problem statement. Greening is a key element of the city's planning structure; it does not only create comfortable conditions for living and recreation, but also has a positive effect on the health of the population. Proper landscaping of territories is essential, as it reduces the negative impact of the environment on humans.

The main purpose of urban greening is to help restore the quality of air. Plants act as a filter, trapping and neutralizing harmful impurities. The effectiveness of this function depends on the diversity of green spaces by origin, age, species and functional composition. Currently, green spaces remain the most accessible and effective tool for improving the urban environment, so expanding their areas in settlements is an urgent need. The best spaces for comfortable recreation in large cities are parks, squares, botanical gardens and forest parks [1].

In addition to local species, the plantations also include introduced species that are resistant to climatic factors and urban conditions and have high aesthetic properties. The introduction of woody plants to Ukrainian lands has a centuries-old history, dating back several millennia. Its origins date back to prehistoric times, when representatives of the local dendroflora were mastered and domesticated, new tree crops were formed, and trees were transferred from other regions. During this period, many botanical gardens and parks were founded. At the same time, information about the biological properties of cultivated breeds was gathered: about growth and development characteristics, resistance to climatic conditions, as well as susceptibility to fungal infections and insect damage.

Introduction is an effective way to expand the range of cultivated flora by introducing ornamental annual and perennial species that are hardy to the specifics of a particular region. This ensures the enrichment of the species composition with original and expressive plants for the needs of urban landscape construction [1, 2].

Creating compositions from decorative deciduous and flowering tree species, in particular introduced species, allows you to expressively combine textures, colors and spatial forms, enhancing the color contrasts of landscape elements. At the same time, it is important not only to expand the range of introduced species for landscaping settlements in Ukraine, but also to systematically assess the condition of already cultivated plants in view of global climate change and the growth of urban-technological load.

Analysis of recent research and publications. Modern cities increasingly need not only aesthetic landscaping, but also a real increase in the ecological sustainability of the urban environment. In conditions of intense technogenic load, air and soil pollution, and overheating of territories in summer, the selection of such tree species that are able to combine high decorativeness with endurance to urban stress factors is of particular importance. One of the promising crops in this context is *Catalpa (Catalpa bignonioides, Catalpa speciosa and their varieties)*, an introduced species that has already proven itself as an effective bioecological and aesthetic component of the urban landscape [3].

Catalpa is characterized by rapid growth, resistance to gas pollution, drought and heat, and its large leaves are able to effectively absorb dust and harmful air pollutants. During the flowering period, the tree turns into a powerful visual and aromatic accent, playing the role of a natural urban art object. At the same time, it creates a favorable microclimate, provides shading and humidification of the air, and becomes a center of biodiversity - attracting pollinating insects and birds [4].

Despite the obvious advantages, the scale of *Catalpa* use in landscaping Ukrainian cities remains insufficient, and the issue of selecting optimal species, forms, and agrotechnical methods for its cultivation requires additional scientific substantiation. That is why the introduction of Catalpa as a decorative and ecosystem species is extremely relevant both for modern landscape design and for the formation of sustainable green infrastructure of cities.

In the Forest-Steppe, the process of adaptation of exotics is closely related to the level of urbanization. In urban conditions, soil compaction, moisture deficiency, increased content of heavy metals and gas impurities in the air are often observed. Some introduced species, in particular *Catalpa*, *gledichia and ailanthus*, are characterized by high technogenic tolerance, the ability to photosynthetic activity even in polluted environments. Due to this, they play the role of natural filters, improving air quality and forming a favorable microclimate of urban ecosystems [1].

The successful adaptation of exotic woody plants to the Forest-Steppe of Ukraine opens up wide opportunities for expanding the range of green plantings. Introduced species not only enrich biodiversity, but also increase the resilience of urbanized ecosystems to climatic stresses. A successful combination of local and exotic species in park and street plantings contributes to the creation of a new type of landscapes - ecologically balanced, decoratively expressive and climatically adapted.

Thus, the experience of acclimatization of exotic tree species in the Forest-Steppe of Ukraine confirms that under conditions of scientifically based selection of species, competent care and monitoring of the biological condition of plants, it is possible to ensure long-term stability and high aesthetic value of green plantings of the region. Exotic species, among which *Catalpa speciosa* and *Catalpa bignonioides* occupy a leading place, become a symbol of a harmonious combination of scientific knowledge, artistic vision and environmental responsibility in modern landscaping of Ukraine [5].

Representatives of the *Catalpa* genus are one of the architectural groups of trees for the urban landscape: large heart-shaped leaves form a dense canopy of shade, lush panicles of flowers in June-July create a distinct seasonal accent, and slender pod-like fruits maintain decorativeness in autumn and winter. Biological plasticity and endurance to urban factors make *Catalpa bignonioides*, *C. speciosa* suitable for various types of plantings - from small courtyards to main green corridors.

In the structure of landscaping, *Catalpa* is the most convincing as a tapeworm on the background of the lawn, the volume of the crown holds the space and sets the center of the composition at the entrances, at the forks of the paths, at the species points of the educational and exposition routes. In alley plantings with an interval of 5-6 m., it forms shaded walking corridors and comfortable microclimatic conditions for recreation.

For streets and squares, *Catalpa* is useful as a dust-collecting and noise-shielding element: a large leaf blade effectively intercepts dust, and a dense crown disperses noise waves, in yards and squares - contrasts with conifers (yew, thuja, juniper) and light-loving flower beds to extend seasonality. The honey-bearing qualities of the inflorescences support pollinators between spring and summer nectar flows, which is important for the biodiversity of the city and the educational programs of the botanical garden [5-7].

The selection of species and forms depends on the task, *C. speciosa* gives a faster spring start and more expressive flowering - optimal for ceremonial axes and early summer accents. *C. bignonioides* retains leaves longer in autumn - advisable where a long-lasting «green background» is needed. In urban conditions, it is worth using container-grown seedlings, forming a strong trunk and opening the crown in the early stages to minimize damage from wind and sleet [8-10].

The requirements for the location are simple but fundamental: full sun or light partial shade, fertile structural soils with drainage, mulch in the trunk circles, watering rarely, but abundantly in the first 2–3 seasons. In urban soil, local soil amendments (compost, biochar) are useful, in the spring - slow-release complex fertilizers. Pruning - mainly formative and sanitary at the end of winter; strong summer pruning is undesirable so as not to provoke fragility of young shoots. It is advisable to protect young plantings from mechanical damage and vandalism [10, 11].

Because of its resistance to urban stresses, long-season decorativeness, and pedagogical value, *Catalpa* is a strategic species for botanical gardens and municipal landscaping. In thoughtful combinations with local species, it enhances the ecosystem services of plantings, expands the palette of forms and textures, and forms a recognizable style of green spaces - from educational and research areas to public parks.

In connection with the mentioned information, **the purpose of our work** is to investigate the features of the introduction of representatives of the genus *Catalpa* in the conditions of the Podillia Botanical Garden of VNAU and to substantiate the feasibility of their use in landscaping settlements in Podillia.

Methodology. The objects of the study are two species of the genus *Catalpa*: bignonioides catalpa (*Catalpa bignonioides Walt*.) and magnificent catalpa (*Catalpa speciosa Warder ex Engelman*) of North American origin. These species grow in street, park and ornamental plantings in settlements of Vinnytsia region.

The study was conducted in 2024–2025 as a field experiment on plots with randomized placement of variants, equalized soil and microclimatic conditions. The recording involved a combination of regular observations and morphometric measurements: growth dynamics in height and number of shoots were observed, the stages of the phenological cycle from budding to the end of flowering were recorded with an assessment of the duration of the phases (Table 1).

Comparative study of two species of *Catalpa* allows to reveal complex patterns of introduction of exotic woody plants into the Forest-Steppe of Ukraine. Biological differences between *C. bignonioides* (as a thermophilic, more decorative species) and *C. speciosa* (as more frost-resistant and technologically convenient for landscaping) create

Table 1

Morphological and ecological features of Catalpa species in the conditions of the «Podillia» Botanical Garden

Type	Morphological features	Frost- and winter hardiness	Drought resistance
Catalpa bignonioides Walt.	Trees from 5 m to 7 m tall, crown wide, spreading. Leaves large, ovate, up to 20 cm, arranged oppositely or in a ring. Flowers creamy white with purple spots, in panicles. Fruits - pods up to 35 cm	Medium frost resistance; shoots may freeze in severe winters, recovers well in spring. Requires sheltered locations	Moderately drought-resistant, loses leaf turgor in prolonged droughts. Requires moist soils
Catalpa speciosa Warder ex Engelm.	Tall trees up to 10 m, pyramidal or rounded crown. Leaves heart-shaped, up to 25 cm, dark green above, light below. Flowers white with yellow and purple spots, large, in paniculate inflorescences. Fruits - pods up to 40 cm long	High frost-resistance, spend winters without significant damage, well acclimatized	Relatively drought-resistant, tolerates short-term moisture shortages, grows well on drained black soil and gray forest soils

Table 2

Rhythm of development of species of the genus Catalpa in the conditions of the «Podillia» Botanical Garden, 2025

№	Phases of growth and development	Phase onset date	
		Catalpa bignonioides Walt.	Catalpa speciosa Warder ex Engelm.
1	**Bud development:**		
	– bud swelling	21.04	15.04
	– bud bursting	30.04	26.04
2	**Leaf development:**		
	– beginning of leaf unfolding	10.05	07.05
	– end of leaf unfolding	13.08	18.07
	– beginning of yellowing	14.09	15.09
	– end of yellowing	28.10	25.10
	– beginning of falling	07.11	30.10
	– end of falling	30.11	21.11
3	**Apical bud formation**	27.07	20.07
4	**Flowering:**		
	– beginning	11.06	04.06
	– mass	16.06	10.06
	– end	26.06	23.06
5	**Fruit ripening:**		
	– beginning of ripening	21.10	20.10
	– end of ripening	30.10	30.10
6	**Shoot growth:**		
	– beginning	05.05	29.04
	– end	19.09	26.07
7	**Vegetation period, days**	183	186

Source: formed on the basis of own research

the basis for a well-founded selection of the assortment of *Catalpas* depending on the functional purpose of green plantings.

Summary of the main research material. During the research, the biological and ecological features of plants were studied: growth and development, flowering and generative process, fruiting, frost and winter hardiness, and their decorative characteristics [11, 13].

Phenological observations were also conducted on representatives of the *Catalpa* genus. During the studies, the following phenophases of development were recorded: bud swelling, bud opening, linear shoot growth, shoot lignification, leaf unfolding, beginning and end of flowering, fruit ripening, leaf color change, leaf fall, beginning and end of fall (Table 2) [14].

The collected phenological data show similar rhythms but different accents of seasonal development of *C. bignonioides* and *C. speciosa*. In *Catalpa*, all spring milestones during the studied year occurred earlier: bud swelling and bud opening preceded *Catalpa* by 6 and 4 days, respectively, from April 15 to April 26 versus April 21 to 30, and the beginning of leaf unfolding was 3 days earlier on May 7 in *C. speciosa* versus May 10 in *C. bignonioides*. Full leaf unfolding was completed almost a month earlier on July 18 in *C. speciosa* versus August 13 in *C. bignonioides*, which indicates a faster spring start of its crown growth.

The autumn period of the annual cycle has its own differences. The dates of the beginning and end of yellowing almost coincide from October 15 to 25 in *C. speciosa* and from October 14 to 28 in *C. bignonioides*, however, leaf fall in *C. speciosa* begins earlier, on October 30, compared to November 7, and ends earlier, on November 21, compared to November 30. Accordingly, *C. bignonioides* retains its leaves longer, maintaining the green volume and expressiveness of the silhouette of the plantations until the end of November. Fruit ripening occurs almost synchronously from October 20 to 30 in *C. speciosa* and from October 21 to 30 in *C. bignonioides*, which is convenient for simultaneous exhibitions and seed selection.

Despite these taxonomic differences, the total duration of vegetation in the species is close to 186 days in *C. speciosa* and 183 in *C. bignonioides*. From a practical point of view, this means that for compositions with an early emphasis on a massive crown and longer flowering, it is advisable to choose *C. speciosa*, while for continued decorativeness in autumn and a distinctive silhouette in the late season, *C. bignonioides* should be preferred. In combination, these species provide a continuous wave of decorative effects from early spring to late autumn, which is especially valuable for educational and exhibition routes in a botanical garden.

Conclusions. Representatives of the genus *Catalpa* have demonstrated high adaptability to the urbanized conditions of Podillia, combining resistance to urban stress factors with pronounced seasonal decorativeness, which enhances the ecological and aesthetic quality of green spaces. A comparison of phenological rhythms revealed significant differences: *C. speciosa* enters the spring phases earlier and blooms somewhat longer, while *C. bignonioides* retains its leaves longer in autumn, forming a late-season green accent, while the total duration of the vegetation period in the species is close, which facilitates joint use in exhibitions. Flowering of both species occurs in June, and fruit ripening occurs synchronously at the end of October, which simplifies seed selection and makes it possible to plan simultaneous demonstrations.

In practice, this means that the feasibility of differentiated use of *C. speciosa* is justified on parade axes and for early summer accents, while *C. bignonioides* is more appropriate for continuing decorativeness in autumn and enhancing the silhouette of plantings. The optimal effect is achieved with the combined introduction of both species in different spatial roles, compliance with the requirements for the growing location (sunny areas, structural drained soils, mulching, moderate watering in the first seasons) and the use of rational shaping and sanitary pruning. Prospects for further research are associated with long-term monitoring of winter hardiness, the study of varietal diversity and phytoindication potential under various technogenic loads, as well as the development of pruning regulations to increase wind resistance in conditions of dense urban development.

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