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BIOLOGICAL, ECOLOGICAL AND MORPHOLOGICAL FEATURES OF SAKURA (*PRUNUS SERRULATA* L.) CULTIVATION FOR FURTHER USE IN LANDSCAPING OF UKRAINE

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Abstract

At present, a great deal of experience has been gained in landscaping and gardening of cities and villages, a rich assortment of landscaping plants has been created and agricultural techniques for their cultivation have been developed, the necessary methods of landscaping specific to cities have been found, and methods of maintaining green spaces have been determined. However, amateur gardeners and professionals working in the field of landscape art are interested in introduced woody ornamental plants that are characterized by high decorative value and have a specific growing season. One of these plants is sakura, a representative of the Prunus L. family - Prunus serrulata L. The main arguments for this are the high decorative qualities of sakura, their resistance to urban conditions, and rapid adaptation to new cultivation conditions. The article presents a brief morphological classification of the most common genotypes of the genus Prunus serullata L. in Ukraine. The biological features of growth, seasonal rhythms of sakura plants development are investigated.

Key words: *sakura, varieties, flowering, cultivation, landscaping.*

INTRODUCTION

The Chinese flowering cherry, also known as sakura or cherry blossom, is an ornamental tree species that blooms beautifully in spring and is globally popular (Shirasawa et al., 2022). The term “sakura” is commonly used to describe deciduous trees belonging to the Rosaceae family (Shibato et al., 2019). Since sakura is a variety of plant species, it has flowers of different colors from pure white to bright pink. But most often, sakura is understood as a representative of the cherry subgenus, especially the fine-pollinated cherry. In 1963, the book “Garden Plants of Japan” was published, compiled by dendrologists from the University of Tokyo.

According to this publication, sakura includes the following species: mountain sakura (*P. Jamasakura*), Edo cherry (*P. yedoensis*), short-bristled cherry (*P. subhirtella*), Sargent cherry (*P. sargentii*), glandular cherry (*P. glandulosa*), bell cherry (*P. campanulata*), fine-sawed cherry (*P. serrulata*), and sharp-sawed cherry (*C. serrulata*) (McClellan, 2005; Moriuchi & Basil, 2019).

The genus *Prunus* L. now unites about 230 species that once belonged to the independent genera *Amygdalus* L. (almond), *Armeniaca* Scop. (apricot), *Cerasus* Mill. (exochorda), *Laurocerasus* Duhamel (laurel), *Maddenia* Hook.f. & Thomson (maddenia), *Oemleria* Rchb. (emberia), *Padus* Mill. (bird cherry), *Persica* Mill. (peach), *Prinsepia* Royle (prinsepia), *Pygeum* Gaertn. (African plum) and some others (Aranzana et al, 2019).

Attempts to taxonomically organize the composition of *Prunus* L. have been going on for more than 300 years, but there is still no consensus on the system of this rather polymorphic genus. It belongs to the Rosaceae family (Perez Zabala, 2022). This is a large family of grasses consisting of three subfamilies: dewy, amygdaloid, and dry, with about 3000 species. The Rosaceae plant family includes grasses, shrubs, and trees, and has a large number of hybrids of different ploidy. The classification of plants belonging to the genus

Prunus L. is quite controversial. These are genotypes of not only cherries, but also plums, cherries, and even bird cherry (Chin et al., 2014).

Prunus serrulata with several intraspecific taxa, including *P. jamasakura* and *P. leveilleana*, is widespread in East Asia. Despite the fact that these taxa are very common, the taxonomic confusion surrounding this complex is reflected in the ambiguity demonstrated by the different taxonomic treatments currently in use. Patterns of intraspecific variability and taxon recognition in the *P. serrulata* complex and related species were investigated on 468 individuals using principal component analysis. Particular emphasis was placed on *P. serrulata*, *P. jamasakura*, and *P. leveilleana* due to their high degree of morphological integration and inconsistent restriction in different systematic treatments. Although morphological variation among different taxa of the *P. serrulata* complex was constant for most reproductive and leaf characters, related taxa (*P. pseudocerasus*, *P. lannesiana* f. *albida*, and *P. sargentii*) appeared to differ in terms of the number of flowers per inflorescence and peduncle length. In general, the number of flowers per inflorescence, flower size, peduncle length, and pedicel hair density are characters of high taxonomic value for most related taxa. However, there is insufficient morphological evidence for the taxonomic division of *P. serrulata* to justify the definition of varieties, with the exception of the pubescent taxon *P. serrulata* var. *pubesecens* (Chang et al., 2007).

Prunus serrulata is native to Japan, Korea and China. The plant is widespread in the western and eastern regions of China, and has also been recorded on the Korean peninsula and in Japan (Iwatsuki et al., 1993; Yi et al., 2020a). The Japanese have established two terms to distinguish wild cherries from cultivated or orchard cherries. These are "Yama-zakura" (mountain cherry) for wild plants and "Sato-zakura" (village cherry) for cultivars. The true non-breeding species *P. serrulata* is rarely sold commercially because it does not have the bright floral traits that highly bred varieties have. It is believed that actively cultivated village cherries began to be grown around the beginning of the seventeenth century (Wybe, 1999), although some varieties may date as far back as 794 and 1192 AD (Honda & Hayashi, 1974). Today, more than 600 varieties of *P. serrulata* are known in Japan, producing bright flowers in spring and beautiful leaf color in autumn. Their exact origin remains rather uncertain. Most of the semi-double forms have certain consistent botanical characteristics that point to the Oshima cherry (*P. speciosa*) as the parent. This species is believed to have a tendency to mutate into double-flowered varieties (Hurr et al., 2022).

Many regions have introduced cherry varieties and researched plant materials from the genus *Prunus* to counteract the monotony that comes after a landscape with cherry blossoms loses its appeal. For centuries, the Japanese have been working on creating new forms of sakura. They have achieved amazing results, as there are plants with double flowers (up to 50 petals) that resemble peonies or chrysanthemums and reach about 6 cm in diameter (Liu et al., 2020).

Despite their uncertain origins, most semi-double forms share some consistent botanical characteristics. Therefore, these forms were grouped as varieties in 1916 by the Japanese botanist Manabu Miyoshi and his American colleague Ernest H. Wilson (Akai, 1974). The Flower Association of Japan, for which the word cherry blossom means the first "cherry blossom," prepared a detailed descriptive manual in 1982 of nearly two hundred species, varieties, and hybrids of Japanese flowering cherries. One of the researchers in the association was the scientist T. Kawasaki, who published Nihonno Sakura (Flowering Cherries of Japan) in 1993. This shows an even more thorough understanding of cherry blossoms and attempts to roughly classify almost 350 cherries into several groups, similar to family trees (Sakurai, 2017).

The Chinese flowering cherry tree has significant economic value due to its great appeal to tourists during the spring bloom. In addition to its aesthetic appeal, it also offers a range of medicinal benefits, including anti-inflammatory properties for the skin, prevention of skin roughness, and inhibition of melanin production. The plant is also used as an ingredient in tea (Shimoda et al., 2011). The polyphenols contained in cherries also help to increase abnormal serum lipid levels, regulate blood glucose levels, and reduce obesity (Yi et al., 2020b). Its beautiful flowers, wide adaptability and high decorative value contribute to its widespread use in urban and landscape design (Wang, 2014).

The *Prunus serrulata* species is well adapted to various climatic conditions (Zhi-xiong et al., 2010). Due to the wide variation in its traits and flower color variations, *P. serrulata* serves as the parent of many ornamental cherry species and is a very important germplasm resource for floral species (Yi et al., 2020a). Using *P. serrulata* as a parent plant, a variety of natural and artificial hybrids have been developed and selected (Ma et al., 2009). Without pruning and under favorable conditions, this cherry tree grows to the size of a full-fledged tree, more than 20 meters high. The Japanese sakura is grown for its beautiful flowers, which appear on the branches every spring and cover almost the entire plant with a pink double blanket. Due to its luxurious flowering, the sakura tree has become widespread in many countries (Salazar, 2022; Kuitert et al., 1999). Some of the cultivated species of *Prunus serrulata* exist as a single monumental specimen or a small group of trees in specialized collections, and are unlikely to deserve cultivar status. Others are well described and commonly found in many parts of the world.

The use of flowering cherries to enhance suburban landscapes and attract public recreation has significant economic and social value. However, the current quality of the cherry landscape is compromised due to a lack of variety selection and planting and design planning. Based on the analysis of public preferences, there is great significance to improve the sustainability of the cherry blossom landscape. The results of the scenic beauty model showed that the cleanliness of the scene (38.04%), the color composition of the plants (25.59%), the road (17.79%), the type of plant (12.88%) and the building (2.70%) were the five key factors affecting the scenic beauty. These study results provide objective reference information for future research on cherry blossom, as well as landscape planning, design, and management (Peng et al., 2024).

Sakura plants should be planted in spring or June, as the seedlings need a long time to adapt. To increase the survival rate of planting material, it should be planted on the south side. Sakura trees prefer an elevated location and grow well on gentle (no more than 10°C) slopes. Damp lowlands, hollows, and forest glades with poor air aeration are not suitable for planting a garden. The root system is not very deep, so to prevent flooding, it is recommended to plant sakura in low-lying areas (Opalko et al., 2016). Sakura trees grow very slowly, so it is advisable to form their crown in 8-10 years. Sanitary pruning is carried out after 2-3 years, removing dry, broken branches and those that show signs of pests and diseases in the spring before the sap flow begins (Polishchuk & Shcherba, 2016). In order to protect plants from diseases, it is advisable to collect and dispose of fallen leaves in the fall. Watering should be done only on the driest days. It is recommended to loosen the soil around the trunks of young plantings, remove weeds and mulch the soil under the plant to protect the roots from overheating and drying out. Sakura looks great both in a single planting: on a lawn in a prominent place, and in various landscape compositions (Frazier, 2014; Ohnuki-Tierney et al., 1998).

The 'Kanzan' variety is very popular in landscape architecture (Maurer U et al., 2003). The 'Shirotae' and 'Taihaku' varieties should be used along pedestrian paths and in places such as shopping centers and hospitals (Forrest, 2006). Sakura is resistant to mild air and soil pollution, but is susceptible to brown stone fruit rot (*Monilia laxa* (*Ehrenb.*) *Sacc.*) if not properly maintained (Ninić-Todorović et al., 2012).

Ukraine has adopted the Japanese tradition of planting sakura on city streets. In recent years, there has been a significant increase in demand for ornamental crops, including sakura planting material. Sakura plants successfully overwinter in Kyiv, Lviv, Zakarpattia, and Moldova. There have been attempts to grow small-saw cherries in Estonia and Latvia, but the climate of northern latitudes is not very suitable for them (Opalko et al., 2018). Today, there are many winter-hardy varieties of sakura, which makes it possible to cultivate it in Ukraine (Polishchuk & Shcherba, 2016; Komar-Temna, 2013). At the same time, the development of varieties with early and stable multi-season flowering and the development of appropriate agricultural practices are two ways to solve the problem of short-term and concentrated flowering of sakura (Xu et al., 2023).

The analysis of literature sources shows that varieties of the genus *Prunus* L. are used for landscaping in Ukraine, but there is almost no scientific literature on the regularities in the rhythm of development, methods of cultivation and possibilities of using sakura varieties for landscaping and gardening, taking into account the peculiarities of the flowering phase.

MATERIALS AND METHODS

The research on the biological, ecological and morphological features of sakura (*Prunus serrulata* L.) cultivation was conducted in 2021-2023 in the botanical garden of the Uman National University of Horticulture. They were carried out according to the Methodology for the examination of plant varieties of the ornamental group for distinctiveness, uniformity and stability, edited by Tkachuk (2016). According to this methodology, the following main phases of sakura vegetation are distinguished the beginning of shoot growth, bud swelling - an increase in their size, the beginning of flowering, the beginning of leafing - the first leaves have unfolded and are similar in shape to the leaves of this species, complete leafing - all leaves acquire normal size, beginning of leaf yellowing - appearance of the first leaves with a changed autumn color, complete leaf yellowing - yellowing of the main part of the leaf mass, beginning of leaf fall - fall of single leaves, complete completion of autumn leaf fall. The flowering phase begins with the blooming of flowers and when about 25% of the buds have blossomed on the tree, the beginning of the flowering phase is recorded, after 75% mass flowering and during the period of 25% of the flowers petals have fallen off - the end of flowering. Determining the phenological phases of development of plants of the genus *Prunus* L., and especially the flowering phases, makes it possible to form different options for landscaping the territory.

Among the varietal diversity of the genus *Prunus* L., special attention should be paid to the varieties *P. serrulata* '*Amanogawa*', *P. serrulata* '*Kiku Shidare*', *P. serrulata* '*Kanzan*' and *P. serrulata* '*Royal Burgundy*', which have successfully passed adaptation and are introduced woody plants in Ukraine. The adaptation of plants to environmental conditions depends largely on their biological characteristics and ability to grow and develop in new soil and climatic conditions. Changes in the growing conditions of ecotypes, compared to the optimal ones, lead to deviations in plant development from the typical ones that are characteristic of the natural range. These changes are especially noticeable between the vegetative development of plants and the formation of generative organs.

The research was conducted with plants of the genus *Prunus serrulata* L., which were bred in Japan, of the following varieties.

The 'Amanogawa' variety

A small tree with a dense columnar crown (Figure 1). Reaches a height of 5 m and a width of 1-2 m. It blooms in May with light pink double flowers 4-5 cm in diameter, collected in bunches. Due to its rather compact size, it can be planted in small gardens as an accent in the rabatka.

Figure 1. Sakura plant of the ‘Amanogawa’ variety

The 'Kanzan' variety

The tree is medium-sized with a reverse pyramidal crown (Figure 2). Each inflorescence consists of 3-5 large densely double deep pink flowers with a purple tint. It blooms from mid-April to the second decade of May. Can be used for tapeworms, group and alley plantings.

Figure 2. Sakura plant of the 'Kanzan' variety

The 'Kiku Shidare' variety weeping form
A small tree with weeping branches and an openwork crown (Figure 3). Reaches a height of 4 m and a width of 3 m. The flowers are double, pink, 6 cm in diameter, collected in bunches of several pieces. Flowering is very abundant. Prefers sun, fertile and moist soils. It is advisable to plant in places protected from cold winds.

Figure 3. Sakura plant of the 'Kiku Shidare' variety

The 'Royal Burgundy' variety
A medium-sized tree with an inversely conical crown and red leaves (Figure 4). The flowers are double, purple-pink, up to 6 cm in diameter, hanging on long pedicels, collected in bunches. It looks spectacular in compositions, alleys, as an accent plant on the lawn.

Figure 4. Sakura plant of the 'Royal Burgundy' variety

All the varieties were brought from the M.M. Hryshko National Botanical Garden of the National Academy of Sciences of Ukraine and the Sofiyivka National Dendrological Park of the National Academy of Sciences of Ukraine and planted on the territory of the Uman National University of Horticulture for further research.

RESULTS AND DISCUSSIONS

The flowering of cherry trees is an effective indicator of climate change impacts on phenology, as the timing of their flowering is highly sensitive to temperature, especially in winter and early spring (i.e. February and March) (Miller-Rushing et al., 2007). From a cultural point of view, accurate prediction of cherry phenology is crucial, as many spring festivals and events around the world are timed to coincide with a specific phenological event - the peak bloom date (PBD).
The blossoming of flowering cherry species (e.g., *Prunus serrulata*, *Prunus × yedoensis*, and *Prunus subhirtella*) is celebrated with festivities in many parts of the world, including the United States, Europe, and Asia (e.g., Washington, D.C., USA; Tokyo and Kyoto, Japan; Jinhae and Seoul, Korea). These spring cherry blossom festivals are culturally and economically important events, and successful planning requires that the cherry blossoms appear as expected during the festival period. In a rapidly changing climate, predicting bloom dates based solely on past history is likely to become less reliable; therefore, a more robust predictive model is needed not only for planning purposes of these cultural events, but also for assessing the agricultural and environmental impacts of climate change (Chung et al., 2011).
Flowering of woody plants is influenced by various factors, including temperature, hormones and nutrition, each affecting plant growth and development to a different degree. Temperature plays an important role in inhibiting plant growth and development. Exposure to low temperatures can damage plant structures, induce stress responses, activate the expression of relevant genes, change the composition and structure of cell membranes, and lead to the accumulation of osmotic regulatory substances to counteract the physical and physiological damage caused by low temperatures (Vosnjak et al., 2021; Kose et al., 2022; Shi et al., 2017). When plants reach the stage of flower bud development, carbohydrates become the fundamental building blocks for converting nutritive growth into reproductive growth. The accumulation of carbohydrates promotes flower bud differentiation (Kataoka et al., 2004). Soluble sugars and soluble proteins in

their leaves are continuously transported to flower buds, providing the necessary substances and energy for bud differentiation (He et al., 2018). The distribution pattern of carbohydrates, proteins, and other nutrients is also closely related to flowering (Zheng et al., 2019).

According to the results of phenological observations, it was found that the vegetation period of *Prunus* L. varieties 209-214 days over the years of research (Figure 5).

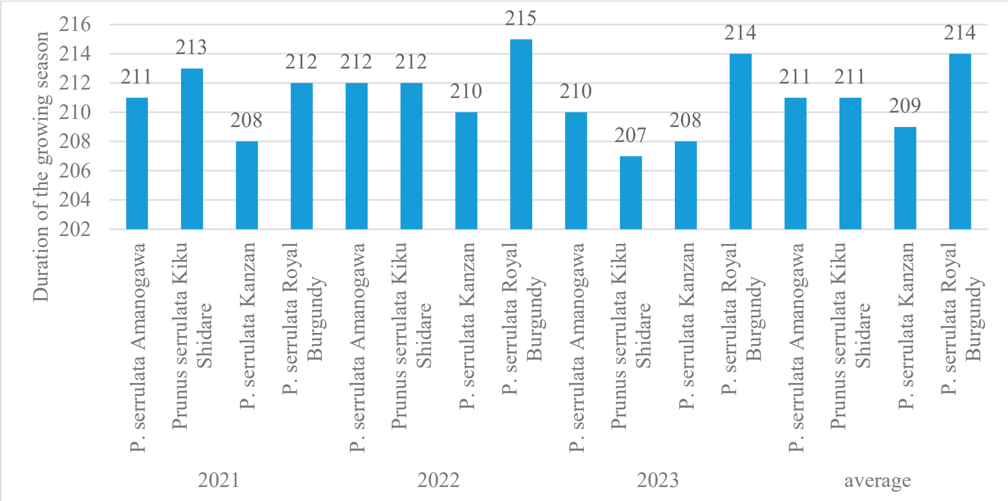

Figure 5. Duration of the growing season of *Prunus* L. varieties (2021-2023), days

No significant change in the length of the growing season was observed by the years of vegetation: if in 2021 the duration of the growing season of *P. serrulata ‘Amanogawa’* was 211 days, in 2022 - 212 days, and in 2023 - 210 days. Similar results were obtained for other varieties.

There were no significant deviations in the length of the growing season by variety. On average, over the years of research, the shortest vegetation period of 209 days was in the variety *P. serrulata ‘Kanzan’*, the longest - 214 days in the variety *P. serrulata ‘Royal Burgundy’*.

In the conditions of the Right-Bank Forest-Steppe of Ukraine, the vegetation of plants of the genus *Prunus* L. began at an average monthly air temperature of +7.4°C (2021), +8.6°C (2022), +8.3°C (2023), in conditions close to the average perennial.

The beginning of the growing season in spring is manifested by the beginning of shoot growth and the extension of bud scales, which protected the plant from negative influences during the autumn, winter and early spring dormant periods.

The phase of bud swelling - increase in their size of all species of *Prunus serrulata ‘Amanogawa’*, *Prunus serrulata ‘Kiku Shidare’*, *Prunus serrulata ‘Kanzan’*, *Prunus serrulata ‘Royal Burgundy’* took place in the late second - early third decades of April. No significant difference in the passage of the bud swelling phase was found both by varieties and years of study. The earliest bud swelling was noted in the *Prunus serrulata ‘Royal Burgundy’* variety: in 2021 - April 18, in 2022 and 2023 - April 16, the latest in the *Prunus serrulata ‘Amanogawa’* variety, respectively - April 20, 22 and 19 (Tables 1-3).

Table 1. Passage of phenological phases of development of plants of the genus *Prunus serrulata* L., 2021

Phenological phases	Date of observation by variety			
	P. serrulata ‘Amanogawa’	*P. serrulata ‘Kiku Shidare’*	*P. serrulata ‘Kanzan’*	*P. serrulata ‘Royal Burgundy’*
1	2	3	4	5
The beginning of the growing season	02.04.2021	03.04.2021	05.04.2021	02.04.2021
The beginning of shoot growth	10.04.2021	11.04.2021	15.04.2021	11.04.2021

Kidney swelling - an increase in their size	20.04.2021	19.04.2021	19.04.2021	18.04.2021
The beginning of flowering	05.05.2021;	07.05.2021;	10.05.2021;	06.05.2021
Beginning of balding - the first leaves have unfolded and are similar in shape to the leaves of this species	08.05.2021	11.05.2021	15.05.2021	14.05.2021
Complete balding - all leaves acquire normal size	22.05.2021	22.05.2021	23.05.2021	23.05.2021
Beginning of leaf yellowing - appearance of the first leaves with a changed autumn color	18.09.2021	20.09.2021	20.09.2021	17.09.2021
Complete yellowing of leaves - yellowing of the main part of the leaf mass	30.09.2021	29.09.2021	30.09.2021	01.10.2021
Beginning of leaf fall - fall of single leaves	15.10.2021	17.10.2021	17.10.2021	19.10.2021
Complete completion of the autumn leaf fall	30.10.2021	02.11.2021	30.10.2021	02.11.2021
Duration of the growing season	211	213	208	212

Table 2. Passage of phenological phases of development of plants of the genus *Prunus serrulata* L., 2022

Phenological phases	Date of observation by variety			
	P. serrulata 'Amanogawa'	*P. serrulata 'Kiku Shidare'*	*P. serrulata 'Kanzan'*	*P. serrulata 'Royal Burgundy'*
The beginning of the growing season	04.04.2022	06.04.2022	05.04.2022	01.04.2022
The beginning of shoot growth	12.04.2022	14.04.2022	13.04.2022	10.04.2022
Kidney swelling - an increase in their size	22.04.2022	21.04.2022	20.04.2022	16.04.2022
The beginning of flowering	06.05.2022;	08.05.2022;	09.05.2022;	05.05.2022;
Beginning of balding - the first leaves have unfolded and are similar in shape to the leaves of this species	10.05.2022	12.05.2022	14.05.2022	12.05.2022
Complete balding - all leaves acquire normal size	25.05.2022	25.05.2022	23.05.2022	22.05.2022
Beginning of leaf yellowing - appearance of the first leaves with a changed autumn color	20.09.2022	23.09.2022	23.09.2022	18.09.2022
Complete yellowing of leaves - yellowing of the main part of the leaf mass	02.10.2022	30.09.2022	01.10.2022	02.10.2022
Beginning of leaf fall - fall of single leaves	16.10.2022	20.10.2022	18.10.2022	16.10.2022
Complete completion of the autumn leaf fall	02.11.2022	03.11.2022	01.11.2022	01.11.2022
Duration of the growing season	212	212	210	215

Observations of the phenological phases of sakura plant development showed that the beginning of the plant vegetation and flowering depended on the sum of effective temperatures, which was 106.5-299.0°C and occurred in the first decade of April and the first decade of May, respectively.

Table 3. Passage of phenological phases of development of plants of the genus *Prunus serrulata* L., 2023

Phenological phases	Date of observation by variety			
	P. serrulata 'Amanogawa'	*P. serrulata 'Kiku Shidare'*	*P. serrulata 'Kanzan'*	*P. serrulata 'Royal Burgundy'*
The beginning of the growing season	07.04.2023	04.04.2023	05.04.2023	01.04.2023
The beginning of shoot growth	14.04.2023	12.04.2023	13.04.2023	10.04.2023
Kidney swelling - an increase in their size	19.04.2023	18.04.2023	20.04.2023	16.04.2023
The beginning of flowering	05.05.2023	04.05.2023	09.05.2023	05.05.2023
Beginning of balding - the first leaves have unfolded and are similar in shape to the leaves of this species	10.05.2023	09.05.2023	14.05.2023	12.05.2023
Complete balding - all leaves acquire normal size	23.05.2023	22.05.2023	23.05.2023	22.05.2023

Beginning of leaf yellowing - appearance of the first leaves with a changed autumn color	18.09.2023	21.09.2023	23.09.2023	18.09.2023
Complete yellowing of leaves - yellowing of the main part of the leaf mass	02.10.2023	29.09.2023	01.10.2023	02.10.2023
Beginning of leaf fall - fall of single leaves	14.10.2023	18.10.2023	18.10.2023	16.10.2023
Complete completion of the autumn leaf fall	01.11.2023	02.11.2023	01.11.2023	01.11.2023
Duration of the growing season	210	208	208	214

The researchers established models of linear and nonlinear relationships between flowering periods and climatic factors by analyzing trends in flowering periods and their correlation with climatic factors. They summarized the relationship between cherry blossom periods and winter temperature changes, contributing to the prediction of flowering periods and the proper planning of cherry blossom landscapes (Chen et al., 2008; Shu et al., 2018; Tan et al., 2021). Previous studies have analyzed the cherry blossom periods and morphological characteristics of cherry blossom landscapes to create an optimal cherry blossom viewing experience. The analysis was based on combinations of flowering periods and general patterns based on different flowering periods and morphological characteristics of different cherry varieties (Chen, 2022). Under Korean conditions, Japanese cherry blossom is expected to bloom 9, 21, and 29 days earlier in the future normal years 2011-2040, 2041-2070, and 2071-2100, respectively. In the southern coastal areas, incomplete or no flowering of Japanese cherries may be observed in spring due to insufficient cooling to interrupt bud dormancy (Jin-I, 2006). On average, over the three years of research, the duration of flowering within each variety did not change significantly. The longest flowering period was observed in the varieties *P. serrulata 'Kiku Shidare'* (21 days) and *P. serrulata 'Kanzan'* (20 days), the shortest in the varieties *P. serrulata 'Amanogawa'* (18 days) and *P. serrulata 'Royal Burgundy'* (18 days). The duration of flowering depended on the weather conditions of the growing season: in 2021, on average, it was 19 days for varieties, in 2022 - 20 days, in 2023 - 18 days (Figure 6).

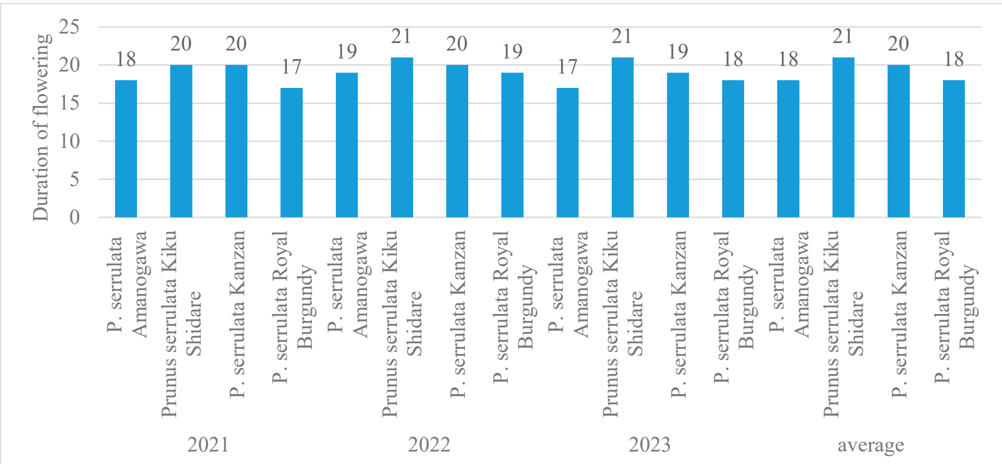

Figure 6. Duration of flowering depending on varietal characteristics and growing conditions, days

Slight differences over the years were found in the duration of the flowering phase of plants, which is associated with varietal characteristics and average daily air temperatures. Thus, in 2021, 2022 and 2023, the longest flowering duration of 20-21 days was in the variety *P. serrulata 'Kiku Shidare'*, and the shortest duration of 17-19 days in the variety *P. serrulata 'Royal Burgundy'*. Taking into account the beginning of flowering and its duration of these varieties, it is possible to form landscape compositions, namely: planting sakura varieties *P. serrulata 'Amanogawa'* and *P. serrulata 'Royal Burgundy'*, in which the flowering phase begins the earliest, but its duration is the shortest, along with the varieties *P. serrulata*

'Kiku Shidare' and *P. serrulata 'Kanzan'*, whose flowering begins later and its duration is longer, which will ensure the continuation of flowering in the composition.

Previously, several studies (Cesaraccio et al., 2004; Jung et al., 2005) showed that a two-stage thermal time-based phenological model successfully predicted the flowering time of temperate tree species, including fruit crops and flowering cherries such as *Prunus serrulata var. spontanea*. Chung et al. (2009) extended the model for native flowering cherries in Korea and applied it to predict current and future flowering dates in South Korea. Under the A2 emissions scenario, the peak flowering of South Korean cherry trees is likely to occur much earlier by an average of 21 days by 2050. At the regional scale, the spatial variability of projected flowering dates increased in the late 21st century, but overall it is projected that the peak flowering is likely to occur 29 days earlier on average by 2080 (Chung U et al., 2009).

The peak bloom dates (PBD) of flowering cherry trees (*Prunus×yedoensis 'Yoshino'* and *Prunus serrulata ''Kanzan"*) in Washington, DC are likely to accelerate by an average of five days by 2050 and 10 days by 2080 for these cultivars under the mid-range (A1B) emissions scenario projected by the ECHAM5 general circulation model. The acceleration is likely to be much greater (13 days for 2050 and 29 days for 2080) under the higher (A2) emissions scenario projected by the CGCM2 general circulation model. These results demonstrate the potential impacts of climate change on cherry blossom timing and illustrate the usefulness of a simple process-based phenological model for developing climate change adaptation strategies in horticulture (Chung et al., 2011).

According to our observations, the beginning of leaf fall - the first leaves that are similar in shape to the leaves of this species, depending on the varietal characteristics begins 3-8 days after the beginning of flowering and on average, in 11-12 days complete leaf fall occurs in varieties.

The beginning of the end of the sakura plant vegetation is the yellowing of the leaves, which began in the beginning of the third decade of September and only varieties in which the flowering phase begins earlier and its duration is shorter, *P. serrulata 'Amanogawa'* and *P. serrulata 'Royal Burgundy'* - at the end of the second decade of September. Full yellowing of the leaves occurs almost simultaneously in all varieties studied - in the first days of October. Over the years of research, no special differences in the passage of these phases of development have been found. In the second decade of October, leaf fall begins, which ends in early November. Depending on the varietal characteristics, there are significant differences both with the beginning of the leaf fall and with complete leaf fall.

CONCLUSIONS

Studies have shown that the introduced plants of the genus *Prunus serrulata* L. are promising for creating plant compositions in the conditions of the Right-Bank Forest-Steppe of Ukraine. The main arguments for this are the high decorative qualities of sakura, their resistance to urban conditions, and rapid adaptation to new cultivation conditions.

It was found that the growing season of *Prunus* L. varieties averaged 209-214 days in 2021-2023. Observations of the passage of phenological phases of sakura plants development made it possible to establish patterns in the rhythm of their development, their dependence on both varietal characteristics and weather conditions of the growing season. It was found that the beginning of the plant vegetation and flowering depended on the sum of effective temperatures, which was 106.5-299.0 °C and occurred, respectively, in the first decade of April and the first decade of May.

We recommend to take into account the beginning of flowering of varieties and the period of its passage, which will ensure the extension of flowering in the garden for 8-10 days and planting sakura varieties *P. serrulata 'Amanogawa'* and *P. serrulata 'Royal Burgundy'* in which the flowering phase begins earlier, and in varieties *P. serrulata 'Kiku Shidare'* and *P. serrulata 'Kanzan'* flowering begins later. Accordingly, the duration of flowering of the first two varieties is shorter compared to the last two.

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