THE ROLE HUDRANGEA (*HYDRANGEA* L.) IN ORNAMENTAL GARDENING AND FLORISTRY: PROPAGATION CHARACTERISTICS

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Introduction. Different climatic zones of Ukraine are characterized by specific conditions that directly affect the local flora. Therefore, to achieve human comfort, it is necessary to adapt approaches to each climatic region.

Green spaces play a crucial role in creating an ecologically balanced urban environment, contributing to improved air quality, reduced noise pollution, and ensuring thermal comfort. Furthermore, they aesthetically enrich the urban landscape. The design and placement of green spaces require a thorough analysis of climatic, soil, and other natural conditions [1, 2, 3].

Since plants in the landscape are living organisms that are constantly developing and changing, a landscaping specialist must consider these processes when creating projects. Only then is it possible to achieve a harmonious combination of functionality for people and integration into the environment. Creating a harmonious and aesthetically pleasing landscape requires not only careful site planning but also consideration of many factors, such as lighting, soil, site style, and building architecture. An important element is also the correct selection of ornamental plants that will organically fit into the overall composition.

Since each plant species has its unique needs, a phytodesigner must have a thorough knowledge of their characteristics to ensure optimal conditions for their development. This includes not only the selection of suitable soil and lighting, but also taking into account the peculiarities of the terrain and climatic conditions of the area where the plants will be located [4].

Problem statement. To create effective landscape compositions, it is necessary to provide high-quality plant material, proper soil preparation, and strict adherence to agricultural requirements. *Hydrangea*, as an ornamental plant, is not widely used in the landscaping of urban areas and public spaces in all cities of Ukraine, despite its distinct decorative characteristics.

According to research by O.M. Korkulenko, conducted in Kyiv, it was found that species of the genus Hydrangea L. are very rarely found in public green spaces, and their species diversity is poor. Only two species are used in the city's green plantings: *Hydrangea arborescens* L. and H. *macrophylla* (Thunb.) DC. They are found mainly in flower arrangements of street plantings.

The low diversity and insufficient use are surprising, as most species of the genus *Hydrangea* L. have high decorative value, varying winter hardiness, drought resistance, resistance to diseases and pests, and are easy to propagate. The problem of expanding the range of plants for cultivation has always been and remains relevant. A significant role of *Hydrangea* L. in the landscaping of Kyiv and the creation of park compositions belongs to introduced plants. In addition to surveying public green spaces, Korkulenko O.M. studied the assortment of nurseries and garden centers, which are the base of primary introduction in the research area. The range of plants in nurseries does not exceed 32 tree species and 35 shrub species, which in turn contributes to the uniformity of the city's green spaces. The assortment of the genus *Hydrangea* L. in the Teremky Municipal Ornamental Nursery is also very limited and represented only by *H. macrophylla* (Thunb.) DC. The author believes that there is a pressing need to expand the assortment with new plant species and forms, including introduced [2, 3. 5, 6].

Hydrangea impresses with the diversity of shapes and sizes of its flowers, which opens up wide possibilities for its use in landscape design. ones. This characteristic allows for the creation of both miniature compositions for small flower beds and impressive ensembles for large city parks [7, 8].

An important characteristic of the hydrangea is its unpretentiousness and ability to adapt well to the urban environment. It can grow successfully both in well-lit areas and in shaded conditions, if provided with moderate watering and regular fertilization. Thanks to its vibrant and impressive flowers, the hydrangea can instantly transform a space, giving it a special charm. It is perfectly suited for both eye-catching solitary plantings and for creating various visual effects, such as zoning the territory or forming vibrant color spots [7].

According to research by Honcharova A.V., conducted in the conditions of the Sofiyivka Research Park, aimed at determining the decorative properties of the Hydrangea genus representatives, the prospects for their use in landscaping and creating landscape compositions were determined. It was found that the studied plants had prolonged flowering and changed the color of leaves and inflorescences during the growing season. The research author believes that members of the Hydrangea genus can also be used in vertical gardening and for decorating the banks of water bodies, strengthening slopes, as well as ground cover plants under tree canopies [9].

It is worth noting that the hydrangea is an extremely versatile plant, allowing it to be used to achieve various goals in the context of urban greening, from creating individual accents to forming large-scale landscape compositions. Examples of hydrangea use in landscaping are shown in Figure 1.



Fig. 1. Use of hydrangea in landscaping [10]

Hydrangea is a true star in the world of floristry, a flower that never goes out of style. Its lush, voluminous inflorescences, resembling clouds, can decorate any event and interior. Thanks to its diversity of shapes, sizes, and colors, hydrangea is a versatile tool for creating various floral arrangements. Its large, spherical, or paniculate inflorescences consist of numerous small flowers, creating an impression of lushness and volume. The diversity of colors – from white and soft pink to rich blue, purple, and even green – allows for the creation of bouquets and arrangements to suit any taste. It is suitable for creating various floral works [2]. Hydrangea can be both the main flower in a bouquet and a wonderful addition to other flowers, such as roses, peonies, and lilies. Its voluminous inflorescences add texture and lushness to the bouquet.



Fig. 2. Hydrangea bouquets [11]

Hydrangeas are used to create a variety of compositions – from small table decorations to large installations for decorating festive events. Hydrangeas are also frequently used in wedding floristry. It is popular for making wedding bouquets and decorating ceremonies [1].



Fig. 3. Hydrangea arrangements [12]

Hydrangea has a multifaceted symbolism that varies depending on culture and context: in Japanese culture, hydrangeas are often given as a sign of gratitude or apology; in Western culture, hydrangeas can symbolize healing, understanding, and sincerity; the lush inflorescences of hydrangeas can also symbolize wealth and abundance. The color of the hydrangea flower also has its own symbolism: white hydrangea symbolizes purity, innocence, new beginnings, often used in wedding bouquets; pink hydrangea is associated with tenderness, romance, sincere feelings, suitable for expressing love and gratitude; purple symbolizes wealth, luxury, elegance, adds sophistication to the bouquet; green hydrangea embodies renewal, growth, prosperity, gives the composition freshness and naturalness [13, 14].

Hydrangea is a popular flower in wedding bouquets and for decorating ceremonies. There are the following styles of wedding bouquet formation:

1.Classic. For a classic wedding, white hydrangeas with corymb inflorescences paired with white or cream roses and peonies are ideal. This bouquet will suit a traditional wedding dress and emphasize the bride's youth and freshness.

2. Rustic. In this type of wedding bouquet, you can use paniculate hydrangeas, whose inflorescences resemble lilacs in shape, adding contrasting field or similar flowers and greenery. Hydrangeas will provide the bouquet with a vertical architecture and add volume, while various additions will add liveliness. Such compositions look relaxed and natural, which is perfect for weddings in nature or in rural areas.



Fig. 4. Wedding bouquets with hydrangeas [11, 15]

3. Modern. In this case, bright inflorescences of saturated shades (for example, deep lilac or red) in combination with exotic plants and succulents of contrasting colors will be suitable. This informal bouquet will emphasize the bride's boldness and originality, creating a striking accent against the overall look. Obviously, such a composition will look harmonious with an appropriate outfit, but not at all with a traditional white dress and veil.

Hydrangea is capable of decorating any event and providing unforgettable emotions. Its use in floristry is limitless, allowing for the creation of unique and unrepeatable compositions

The aim of the work. This study aims to comprehensively analyze the decorative qualities, biological, and morphological parameters of various species and varieties of the genus *Hydrangea L.*, adapted to the conditions of the city of Sumy, to expand the possibilities of their use in landscape design. An important aspect of the research is the study of the effectiveness of various hydrangea propagation methods, including the use of biologically active substances to stimulate the rooting process.

The material for research were: - articles by domestic and foreign scientists; - seeds of three varieties of *Hydrangea* macrophylla coptib (Nikko Blue, Twist-n-Shout, Endless Summer); - *Hydrangea* cultivar plants: Baunti (*H arborescens*), Bobo (*H. paniculata*), Twist-n-Shout (*H. macrophylla*).

Research methods. Phenological observations were conducted to determine the onset and mass ripening of fruits. Bioecological methods were used to determine the dynamics of shoot growth, reproductive capacity, abundance of flowering, and fruiting. Morphological, qualitative, and sowing indicators of seeds were determined to assess their quality. The effectiveness of two methods of hydrangea cultivation, by seeds and green cuttings, was evaluated. During the research, we conducted phenological observations of three hydrangea species: Hydrangea arborescens, Hydrangea paniculata, and Hydrangea macrophylla. To assess the abundance of flowering and fruiting according to the methodology proposed by V. G. Kapper, with a modification by O.A. Kalinichenko, the dates of the beginning and mass ripening of fruits were also determined. Morphological characteristics of *Hydrangea L*. seed were also studied in three varieties: Bounty, Bobo, and Twist-n-Shout. Seed sowing qualities were also determined [11].

In a study conducted using the methodology of Kolesnichenko O. V., two methods of *Hydrangea* propagation were investigated: seeds and cuttings. To increase the rooting efficiency of/ cuttings, growth stimulants heteroauxin, Kornevin, and succinic acid were used [11].

Location and conditions of the research. The research was conducted in the laboratory of Sumy National Agricultural University, located in the southeastern part of the Sumy region, in the city of Sumy, in the Forest-Steppe zone. The landscape of the site where the educational laboratory of horticulture and viticulture is located includes a typical plain with a slight southwest slope, intersected by deep ravines and gullies, often shaped like «saucers». The Psel River flows east of SNAU, approximately 8 kilometers away.

The soil in the research area is typical chernozem with deep bedding, medium loamy granulometry, a small amount of organic matter, and a coarse dusty structure.

The soil in the research area is characterized by the following agrochemical indicators: the soil solution reaction is close to neutral (pH 5,8-6,0), meaning the soil is neither acidic nor alkaline; the humus content in the arable layer is 3.9%; the soil rating is assessed at 79 points, a high indicator of high soil fertility; calcium and magnesium ions predominate in the soil adsorption complex, which also contributes to increased soil fertility; the arable layer has significant reserves of nutrients such as nitrogen (9 mg/100 g soil), phosphorus (14,0 mg/100 g soil), and potassium (6,7 mg/100 g soil). These nutrient reserves are sufficient to meet the needs of fruit and berry crops; the maximum hygroscopicity of the soil is 1.6 meq/100 g, indicating that the soil is capable of retaining a significant amount of water.

The soils in the research area are level, allowing for the cultivation of various agricultural crops without the risk of losing the fertile layer. These soils are typical of the Forest-Steppe of Ukraine, making them suitable for conducting research related to this zone.

Weather conditions during the research period. The climate in the region where the research was conducted is temperate continental. According to long-term data, the average annual air temperature is +7.4°C. The highest temperatures were recorded in July (+38.5°C), and the lowest in January (-36.0°C). Figure 5 shows the meteorological conditions of the 2023 growing season.



Fig. 5. Meteorological conditions of the 2023 growing season (according to Sumy meteorological station data)

The annual sum of temperatures above 10°C is 2500-2650°C. The average duration of the frost-free period is 275 days. Precipitation throughout the year is unevenly distributed, with the highest amount falling in July, averaging 76 mm according to long-term data. In individual years, the amount of precipitation can significantly differ from the long-term average. The total average annual precipitation is 593 mm, and the hydrothermal coefficient ranges between 1,1-1,2.

Thus, the analysis of the 2023 growing season indicates that the soil and climatic conditions of this region are favorable for growing hydrangea species.

Results. We conducted a study of the decorative properties of three hydrangea species: *H. arborescens, H. paniculata*, and *H. macrophylla* (Table 1).

Type of culture	Bush form	Height, m	Inflorescen ce form	Infloresce nce diameter, cm	Infloresc ence color	Leaf shape	Leaf color
H. arborescens	Round	1,5	Globular	10 до 25	creamy	Large, oval with serrated edges	in summer - deep green, in autumn - bronze hue
H. paniculata	Compact, rounded	1,6	Pyramidal	18-30	first white then pink	elliptical with serrated edges	in summer - deep green, in autumn - bronze hue
H. macrophylla	Spreading, compact	1,5	Flat corymbs	15-25	from white, pink, and red to blue and purple	large, oval or elliptical, with serrated edges	deep glossy green

Table 1. Evaluation of the decorative properties of Hydrangea L.

Hydrangea arborescens is a popular hydrangea species valued for its low maintenance, abundant and long-lasting blooms, and high frost resistance.

The *Hydrangea arborescens* shrub has a rounded, spreading form. It typically reaches a height of 1-1,5 meters. The crown diameter can be approximately the same as the height. The shoots are strong, upright, hold the shape of the bush well, and do not require support, even under the weight of large inflorescences.

The inflorescences are spherical, quite large, with a diameter of 10 to 25 cm, sometimes even larger. The typical color of the inflorescences is white or cream. There are also varieties with pink, greenish, or lime shades. Some varieties can change color during flowering. *Hydrangea arborescens* blooms profusely and for a long period – from June-July to September-October. Flowering occurs on the current year's shoots, which ensures annual abundant flowering, regardless of the severity of winter.

The leaves are large, oval or elliptical, with serrated edges. In summer, they are a deep green color. In autumn, the leaves can take on yellowish or bronze hues, adding to the shrub's decorative appeal in the fall season.

Hydrangea arborescens maintains its decorative appeal throughout the season: in spring – thanks to the fresh green foliage, in summer – thanks to the abundant flowering, in autumn – thanks to the autumn coloring of the leaves and the dry inflorescences, which can remain on the bush throughout the winter, giving it a graphic quality.

Hydrangea arborescens looks great as a solitary plant, in group plantings, in compositions with other shrubs and perennials, and also for creating hedges. It can be used for landscaping parks, squares, and gardens of various styles..

Varieties of *Hydrangea arborescens*: Annabel, Khaies starberst, Baunti, Hrandiflora, Laim Riki. Figure 6 shows photos of *Hydrangea arborescens* varieties.



Hydrangea arborescens Annabelle [16]





Hydrangea arborescens Hayes Starburst [17]

Hydrangea arborescens Bounty [16]



Hydrangea arborescens Grandiflora [18]



Hydrangea arborescens Lime Rickey [16]

Fig. 6. Photos of Hydrangea arborescens varieties

In panicled hydrangea (*Hydrangea paniculata*), the bush can have a variety of shapes: from compact, rounded to spreading, with upright or slightly drooping shoots. It typically reaches a height of 1,5-2 meters, with some varieties growing up to 3 meters. The crown diameter can be approximately the same as the height. Shoots are strong, maintaining the bush's shape well, especially in young plants. With age, the shoots may slightly droop under the weight of large inflorescences. The inflorescences are paniculate, pyramidal or conical in shape, consisting of a large number of small flowers.

The flowers of *Hydrangea paniculata* are striking in their ability to change color throughout the flowering period. From initial white or cream shades, they gradually transition to a variety of colors: pink, red, burgundy, lime, or greenish. The intensity and specific shade of the color are influenced by factors such as the plant variety, light level, air temperature, and other growing conditions. *Hydrangea paniculata* blooms very profusely and for a long time – from July to the end of September or even October. Its leaves have an oval or elliptical shape with characteristic serrated edges and a rich green color. In autumn, the leaves of some varieties may change their color to yellow or reddish, although this is not a typical characteristic for all varieties.

Hydrangea paniculata is an adornment to the garden in any season. In spring, it delights the eye with the succulent greenery of its leaves. In summer and autumn, the time of its lush flowering arrives, when the inflorescences gradually change their color, creating a unique palette. And in winter, even after the leaves have fallen, the dry inflorescences, covered with frost, look like delicate lace.

Hydrangea paniculata is perhaps the most well-known type of hydrangea, striking with its large, vibrant inflorescences of various colors. Its decorative appeal is due to many factors.

Hydrangea paniculata varieties: Polar Bear, Limelight, Bobo. Photos of panicled hydrangea inflorescences are shown in Figure 7.



Hydrangea paniculata variety Polar Bear

Hydrangea paniculata variety Limelight

Fig. 7. Photos of Hydrangea paniculata varieties [16].

Hydrangea macrophylla is the most well-known type of hydrangea, striking with its large, vibrant inflorescences of various colors. Its decorative appeal is due to many factors. The bush is usually rounded or spreading, compact, depending on the variety and growing conditions. Its height typically reaches 1-1,5 meters, and the crown diameter is approximately equal to the height.

Shoots are quite strong, but may require support under the weight of large inflorescences, especially after rain. Inflorescences are capitate (head-like) or corymbose (flat-topped), consisting of a large number of sterile flowers, while corymbose inflorescences have large sterile flowers at the edges and smaller, fertile flowers in the center. In acidic soil (pH 4,5-5,5), inflorescences acquire blue or purple coloration. In neutral or alkaline soil (pH 6,5-7,5), inflorescences become pink or red. White varieties do not change color depending on soil pH. Inflorescences are quite large, reaching 15-25 cm in diameter, and

Hydrangea paniculata variety Bobo

sometimes even more. Bigleaf hydrangea blooms from July to September. The leaves have an oval or elliptical shape with serrated edges. They are large in size, a rich green color, and glossy.



Fig. 8. Photos of bigleaf Hydrangea macrophylla [8]

Hydrangea macrophylla varieties: Endless Summer», Nikko Blue, Twist-n-Shout, All Summer Beauty, Pia, L.A. Dreamin. The duration of the decorative period from spring to autumn – thanks to the bright inflorescences. Bigleaf hydrangea is able to decorate any garden with its lush and vibrant inflorescences. Its ability to change color depending on soil acidity adds to its special appeal and allows for the creation of interesting compositions. It is important to consider the specifics of caring for this species to ensure abundant and prolonged flowering

To better understand the developmental characteristics of hydrangea and its response to the environment, we conducted phenological observations on three hydrangea varieties: Bounty (*Hydrangea arborescens*), Bobo (*Hydrangea paniculata*), and Twist-n-Shout (*Hydrangea macrophylla*). The results of the phenological observations are presented in Table 2.

		Budding	Flowering			
Variety name	Beginning of vegetation		Beginning	Completion	Fruit formation	Onset of dormancy
Bounty (Hydrangea arborescens)	21.03	9.05	25.06	25.09	20.10	5.11
Bobo (Hydrangea paniculata)	30.03	14.05	30.06	4.10	29.10	15.11
Twist-n-Shout (Hydrangea macrophylla)	5.04	22.05	6.07	10.10	6.11	30.11

Table 2. Results of phenological observations, 2023

According to our observations in 2023, the average daily air temperature crossed 0°C upwards on March 7th, indicating that the winter period had ended and spring had begun. The snow cover completely melted on March 14th. The beginning of vegetation recovery in 2023 for Hydrangea arborescens occurred on March 21st; during this period, the air temperature consistently exceeded $+5^{\circ}$ C.

In *Hydrangea paniculata*, the beginning of vegetation occurred on March 30th, and in Hydrangea macrophylla, on April 5th. The first sign of the beginning of vegetation is the swelling of buds on the shoots. During this period, they increase in size and become noticeable. Then, the first leaves appear, and sap flow in the plant intensifies. During this period, it is important to provide hydrangeas with proper care to stimulate their active growth and flowering. Prune the bush, removing damaged and weak shoots. Feed the plant with a complex mineral fertilizer. Provide regular watering, especially in dry weather. Protect the hydrangea from possible frosts if they are forecasted.

The next phase in hydrangeas is budding. During this period, the formation of buds occurs, which precedes flowering. This process in the Bounty variety began in the first ten days of May, in the Bobo variety in mid-May, and in the Twist-n-Shout variety in the third ten days of May. The first sign of budding is the appearance of small, greenish tubercles on the ends of the shoots or in the leaf axils. Over time, these tubercles increase in size and take the form of buds.

For successful budding, hydrangeas require sufficient light, moisture, and nutrients. It is important to provide regular watering and feeding of the plants during this period. During the budding period, it is especially important to protect hydrangeas from frosts, which can damage the buds. It is also recommended to remove weeds and loosen the soil around the plants to ensure air access to the roots. To achieve more lush hydrangea flowering, we removed excess buds, leaving only a few on each shoot. The next phase in the studied varieties was flowering. This phase of plant development occurred in *Hydrangea arborescens* and *Hydrangea paniculata* in late June. *Hydrangea macrophylla* 'Twist-n-Shout' began flowering in the first ten days of July. The beginning of flowering is the phase during which the first flowers open. Mass flowering is the period when most flowers are open. The end of flowering is the beginning of wilting and shedding of flowers. This phase of plant development began first in *Hydrangea arborescens*. The Bobo and Twist-n-Shout varieties finished flowering in the first ten days of October.

The fruit formation phase coincided with the yellowing and leaf fall in the Bounty and Bobo varieties in the third ten days of October, and in the Twist-n-Shout variety in early November.

According to our research in 2022, the cessation of vegetation occurred in *Hydrangea arborescens* in the first ten days of November, in the Bobo variety in the second ten days, and in the Twist-n-Shout variety at the end of November.

Seed yield assessment. Most ornamental flowering plants successfully propagate by seed, although the result can vary depending on environmental conditions, care, and genetic characteristics. As for shrub plants, many of them reach reproductive age as early as 2-3 years, again, depending on growing conditions [18].

Various factors influence the seed quality of many tree and shrub species, including the formation of non-viable or sterile pollen, incomplete pollination due to unfavorable weather conditions, low productivity of the male generative sphere, limited number of plants per area, genetic uniformity, as well as damage by pests and diseases [19].

Ornamental flowering plants can produce seeds with both high and low sowing qualities. In this regard, seed quality analysis, including varietal characteristics, is a mandatory step before its use and during storage [20].

Seed propagation is an effective method for many ornamental plants capable of generative development. However, it should be noted that the inheritance of traits in offspring can be quite variable - from 10 to 60%. Therefore, seedling selection is an important step to achieve the desired result.

Introduction of woody plants is an effective way to enrich genetic material for breeding. Adaptation to new conditions promotes the emergence of diverse variations that can be used to create new varieties. At the age of 1-2 years, seedlings may exhibit changes in leaf color. The advantages of seed propagation include a stronger root system, resistance to diseases and pests, as well as a longer lifespan [18, 20].

To predict future yields and assess the actual productivity of the generative sphere of plants, we evaluated the abundance of generative organ formation in the *Hydrangea L*. genus of three species: *Hydrangea arborescens* Bounty, *Hydrangea paniculata* Bobo, and *Hydrangea macrophylla* Twist-n-Shout.

Hydrangea arborescens has a fruit that is a light brown capsule, which has a spherical shape and ten elongated ribs. It has two divergent columns on top. The fruit diameter ranges from 1.5 to 2.0 mm. The seeds have an oval or broadly elliptical shape, with a bluntly pointed end at the base. The seed surface is longitudinally furrowed, smooth, and glossy [21, 22].

Hydrangea macrophylla is characterized by the following fruit features: a dark gray capsule with three or four divergent columns at the top. The capsule length is approximately 3 mm (up to 4 mm with columns), and the width is about 2 mm. The capsule base has a cone-shaped form and narrows towards the pedicel.

On the calyx surface, elongated-ribbed formations are observed. The seeds have an irregularly oval shape, with no noticeable wing. The seed surface appears finely elongated-furrowed, smooth, and glossy [21, 22, 23, 24].

Hydrangea paniculata is characterized by the presence of a brown, elliptical fruit with 2-3 divergent columns. The length of this capsule ranges from 2.5 to 3.0 mm (about 3.5 mm with columns), and the width is approximately 2 mm. The region under the calyx has elongated ribs. The seeds have a lanceolate shape, with wings attached at both ends. The seed surface appears longitudinally furrowed, smooth, and glossy [3, 6, 21].

To assess flowering and fruiting, we used the methodology proposed by V.G. Kapper (1930), with modifications by O.A. Kalinichenko (1970). In this methodology, each of the six points corresponding to flowering and fruiting is assigned a specific number of generative organs. The fruit ripening time is determined during regular phenological observations [18, 22].



Fig. 9. Photos of Hydrangea L. seeds

The research results concerning the beginning and mass ripening of fruits are presented in Table 3.

	Fruit	Number of days from the		
Crop type	Beginning	Mass fruit ripening	end of fertile flower blooming to mass fruit ripening	
H. arborescens	20.10.2023	29.10.2023	113	
H. paniculata	29.10.2023	9.11.2023	88	
H. macrophylla	6.11.2023	11.11.2023	107	

Table 3. Dates of the beginning and mass ripening of hydrangea fruits

Through phenological observations, we found that *H. arborescens* fruits began to ripen first on October 20 th. *H. paniculata* ranked second in ripening, with its fruits starting to ripen on October 29 th. *Hydrangea macrophylla* fruits began to ripen last.

The harvesting of *H. arborescens* fruits was carried out on October 29 th, and accordingly, *H. paniculata* on November 9 th, and *H. macrophylla* on November 11th.

The results of the flowering and fruiting abundance assessment of the plants are recorded in Table 4.

Table 4. Results of the flowering and fruiting abundance assessment

Flowering abundance, Fruiting abundance, Fruit har

№ п/п	Species	Flowering abundance, score	Fruiting abundance, score	Fruit harvesting date
1	H. arborescens	5,0 (85 %)	4,2	29.10.2023
2	H. paniculata	5,0 (93 %)	5,0	09.11.2023
3	H. macrophylla	3,0 (60 %)	2,8	11.11.2023

Based on research conducted in 2023, it was found that *Hydrangea arborescens* and *Hydrangea paniculata* had a high level of flowering (5 points), with the crowns of these species covered with generative organs very well, at 85% and 93% respectively. In *Hydrangea macrophylla*, the crown was covered with generative organs by 60% and corresponded to 3 points, a medium level.

The fruiting abundance of the studied species ranged from 5 to 2.8 points. The highest fruiting rate was found in *H. paniculata* at 5 points, the lowest belonged to *H. macrophylla* (2,8 points), and the average was in *H. arborescens* (4.2 points). Seed quality indicators and morphological features of *Hydrangea L.* species are shown in Table 5.

Table 5. Characteristics of seeds of common hydrangea species under the conditions of Sumy city

Variety name	Germination	Seed dimensions, mm		Surface coloration	Weight of 1000
and species	rate, %	length	width	Surface coloration	seeds, g
Bounty (H. arborescens)	97,0	0,80	0,40	Dark brown	0,030
Bounty (<i>H. paniculata</i>)	30,0	2,58	0,50	Brown	0,028
Twist-n-Shout (H. macrophylla)	79,0	0,75	0,35	Sand-colored seeds	0,030

Seeds were germinated indoors at a temperature of $+18...+20^{\circ}$ C on white filter paper. The filter paper was cut, moistened by dipping it in boiling water, and then allowed to drain excess water, and placed in Petri dishes in 2-3 layers. The study was conducted in four replicates (20 seeds in each variant). The

highest germination rates were observed in the Bounty variety, 97%. The second position was occupied by the *Hydrangea macrophylla* variety Twist-n-Shout, with a germination rate of 79%. The lowest germination rates were noted in the Bobo variety, a *Hydrangea paniculata* species.

After examining the seeds of three hydrangea species, we noticed that the 'Bobo' variety had the greatest length (seed size $2,58 \times 0,50$), and the Bounty and 'Twist-n-Shout' varieties were almost the same size. The weight of 1000 seeds in the three species ranged from 0,028-0,030 g.

Features of *Hydrangea L*. seed propagation. For this experiment, seeds of the Hydrangea macrophylla species of three varieties were used: Nikko Blue (blue flowers), Twist-n-Shout (pink flowers), Endless Summer (flowers change color depending on soil acidity, can be both pink and blue).



Fig. 10. Purchased Hydrangea L. seeds

First, the seeds were disinfected with manganese. Then, they were placed on damp cotton wool to prepare them for sowing.



Fig. 11. Seed preparation for sowing



Fig. 12. Germinated Hydrangea L. seeds

Seed boxes were used for sowing seeds. A soil mixture for hydrangeas was purchased, containing the following components: sod soil + leaf soil + sand (1:1:2). Before sowing, the prepared substrate was moistened. Since hydrangea seeds are very small, when sowing them in boxes, they were not covered with soil, but only pressed tightly against it.



Fig. 13. Sown hydrangea seeds in soil

After sowing, the boxes with seedlings were carefully watered with a spray bottle, covered with a transparent bag, and the temperature regime was maintained within 18-22 °C. Under these conditions, the air above the seedlings under the bag became saturated with moisture, which contributed to rapid swelling and germination of seeds. The main mass of seeds germinated within 9-16 days after sowing.

After the seeds were sown, further care consisted of ensuring constant air humidity through regular watering with a sprayer. To protect against direct sunlight, the delicate seedlings were grown in shaded conditions. After germination, the seedlings were gradually acclimatized to fresh air. The

seedlings successfully developed in diffused light conditions, but poorly tolerated prolonged exposure to direct sunlight.

One of the necessary steps to obtain healthy hydrangea seedlings is transplanting young plants. After they have developed 1-2 true leaves, the seedlings were transplanted into cups filled with the same soil mixture that was used for the initial sowing. Photos of Hydrangea L. seedlings are located in Figures 14 and 15.



Fig. 14. Pricked-out hydrangea seedlings



Fig. 15. Seedlings 6 months of growth Hydrangea L.

Seedlings were transplanted into moist and loosened soil to the depth of the cotyledon leaves. In the first days, they were shaded to protect them from direct sunlight.

Table 6 shows the sowing and emergence dates of Hydrangea macrophylla seedlings.

Table 6. Average dimensions of six-month-old Hydrangea macrophylla seedlings, cm

Variety name	Sowing date	Seedling emergence date	Average plant height at six months of age, cm
Nikko Blue	10.03.2023	20.03.2023	8,0
Twist-n-Shout	10.04.2023	25.04.2023	5,0
Endless Summer	10.05.2023	22.05.2023	6,5

All varieties of *Hydrangea macrophylla* were sown at different times. The Nikko Blue variety was sown on March 10 th and seedlings appeared after 10 days. The Twist-n-Shout variety was sown on April 10 th, and seedlings were obtained on the 15th day after sowing. The Endless Summer variety was sown on May 10 th, and seedlings were obtained on the 12 th day. All seedlings were grown under the same conditions at a temperature of 18-22 °C and with systematic watering.

The germination date depended on the genetic characteristics of the varieties. The highest average plant height at six months of age was observed in the Nikko Blue variety and was 8 cm. This can be explained by the fact that plants of this variety reach a height of 1,5 m in adulthood. In second place in terms of the height of six-month-old seedlings was the Endless Summer variety, its height was about 6,5 cm, adult plants have a height of 1,2 m. The Twist-n-Shout variety plants were the shortest at six months of age. The height of adult plants of this variety is usually about 90 cm.

Features of propagating *Hydrangea L.* by green cuttings. A common method of vegetative propagation is the use of stem cuttings. The theoretical basis for this method is the results of numerous researchers [25]. The efficiency of the work depends on various factors, such as the age of the mother plants, their successful growth and development, the physiological state of the cuttings used, the timing of harvesting, the method and preparation of the cuttings for planting in the substrate, as well as the conditions created for rooting, and the quality and characteristics of the care of the cuttings [26].

In our research, we used the method of rooting hydrangeas with green cuttings in three periods using growth stimulants. We used well-known root formation stimulants that can be purchased in stores. These products were used in the form of aqueous solutions with the following concentrations: heteroauxin (200 mg/l), Kornevin (2.0 g/l), succinic acid (1 g/l).



Fig. 16. Green cuttings of Hydrangea L.

The experiment was conducted in four variants:

Variant 1 – control;

Variant 2 – plants were treated with heteroauxin;

Variant 3 – plants were treated with Kornevin;

Variant 4 – plants were treated with succinic acid.

As a mother plant, bushes of the Bounty variety (Hydrangea arborescens) were used. The results of rooting cuttings are shown in Table 7.

	Experiment variants	Loss rate	Cuttings rooting periods			
№			15.06.2023	30.06.2023	15.07.2023	
			% of rooted cuttings			
1	Control	-	55	65	40	
2	Heteroauxin	200 мг/л	72	83	60	
3	Kornevin	2,0 г/л	80	90	70	
4	succinic acid	1 г/л	67	75	50	
HIP ₀₅			4.	56		

Based on the research results, we observed that the highest rooting success of green cuttings was noted when using Kornevin, while the lowest percentage of rooting was observed in the control group.





Fig. 17. Rooted cuttings of H. arborescens

To better characterize the effect of growth regulators on the rooting of *Hydrangea arborescens*, the obtained research results were grouped into a diagram in Figure 14.



Fig. 18. Effect of growth regulators on the rooting of Hydrangea arborescens

It can be concluded that the use of preparations to stimulate root formation has a beneficial effect on the rooting of green cuttings of *Hydrangea arborescens*. Through research, it was found that the best time for rooting *Hydrangea arborescens* is the end of June.

Conclusions.

1. The role of Hydrangea L. in ornamental gardening and floristry was studied and analyzed.

2. The main types and varieties of hydrangea used in ornamental gardening and floristry are described.

3. The aesthetic and functional advantages of hydrangea in landscape design and floral compositions were analyzed.

4. Throughout the growing season, phenological observations were conducted, which showed that the fruits of *Hydrangea arborescens* ripened first – on October 20th. Hydrangea paniculata (October 29th) and Hydrangea macrophylla (November 6th) took second place in terms of ripening. Mass fruit ripening occurred on October 29th in Hydrangea arborescens, November 9th in Hydrangea paniculata, and November 11th in Hydrangea macrophylla.

5. To predict future yields and assess the actual productivity of plants of the genus *Hydrangea L.*, we evaluated the abundance of generative organ formation. *Hydrangea arborescens* and *paniculata* had a high level of flowering (5 points). Hydrangea macrophylla had a medium level of flowering (3 points). The highest fruiting rate was found in the species *H. paniculata* (5 points). The highest seed germination rate (97%) was established in the *Hydrangea arborescens* variety Bounty. The seeds of three hydrangea species, varieties Bounty, Bobo, and Twist-n-Shout, were studied for morphological characteristics. The weight of 1000 seeds in the three species ranged from 0.028-0.030 g.

6. An analysis of the effectiveness of two methods of hydrangea propagation was conducted. The study examined two methods of hydrangea propagation: seed and vegetative.

7. In seed propagation, the fastest shoots appeared in the Nikko Blue variety on the 10th day after sowing. At six months of age, this same variety had the highest average plant height.

8. For vegetative propagation, the method of rooting green cuttings was used. To increase the efficiency of cutting rooting, growth stimulators were used: heteroauxin, Kornevin, and succinic acid.

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