

Assessment of Vitality and Ornamental Quality of *Hydrangea paniculata* Siebold Cultivars under Urban Conditions of the Volga Region

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Abstract. Ten cultivars of *Hydrangea paniculata* Siebold were investigated in Saratov, Russia, over three growing seasons (2022-2024). Plant vitality was assessed using Nikolaevskiy's methodology based on four morphological indicators, yielding an integrated vitality score. Ornamental quality was evaluated according to Fedin's methodology across eleven criteria, including inflorescence colour, flowering duration, fragrance, and winter hardiness. Specimens were examined at ten urban green space types, representing varying levels of anthropogenic stress. Seventy percent of the plants demonstrated excellent vitality (39-40 points), classified as “no signs of decline”. Four-cultivars – ‘Pinky Winky’, ‘Summer Love’, ‘Limelight’, and ‘Bobo’ – were identified as highly ornamental (80-85 points) and resilient under local conditions. ‘Skyfall’ and ‘Strawberry Blossom’ exhibited reduced winter hardiness, with >50% dieback of annual shoots. The study established science-based recommendations for selecting *H. paniculata* cultivars suitable for sustainable urban –greening in the Volga region.

1 Introduction

In modern urban environments, woody ornamental plants that combine high aesthetic value with resilience to anthropogenic stressors play a key role in shaping sustainable green spaces [1].

Hydrangea paniculata Siebold is widely used in landscape design due to its prolonged flowering, diverse cultivar range, and good adaptability. However, the successful application of this species in specific climatic conditions requires confirmation through field observations.

Despite the widespread cultivation of *H. paniculata* in Russia, reliable data on the vitality and ornamental quality of modern cultivars under the conditions of the Saratov region remain limited. Most current recommendations are based on observations from central regions of the Russian Federation or international sources [2], which do not account for the specific climate of the Volga region – characterized by sharp temperature

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fluctuations, low atmospheric humidity, and high levels of industrial and traffic-related pollution.

The aim of this study was to conduct a comprehensive assessment of the vitality and ornamental quality of ten *H. paniculata* cultivars growing in various types of urban green-spaces in the city of Saratov. The results will provide science-based recommendations for selecting cultivars suitable for sustainable urban greening.

2 Materials and methods

The study was conducted over three growing seasons (2022-2024) in the city of Saratov (51°32' N, 46°00' E), located in the forest-steppe zone of the Volga region. Climatic conditions during the observation period were close to long-term averages: mean annual air temperature was +6.8 °C, and total annual precipitation ranged from 480 to 520 mm, with a pronounced maximum during the warm season. The research objects included ten cultivars of *Hydrangea paniculata* Siebold: 'Pinky Winky', 'Bobo', 'Polestar', 'Selection', 'Limelight', 'Skyfall', 'Summer Love', 'Samarskaya Lydia', 'Strawberry Blossom', and 'Sundae Fraise'.

All plants were grown under urban conditions on urbanozems – anthropogenically transformed soils typical of landscaped areas in Saratov. The soils exhibited slightly acidic to-neutral pH (5.8-7.0), moderate humus content, and were subject to compaction and localized salinization.

Plant vitality was assessed using the methodology developed by V.S. Nikolaevskiy [3], which includes four morphological indicators: crown foliage density, proportion of live shoots, condition of the leaf apparatus, and annual shoot growth. Based on these parameters, an integrated vitality score was calculated.

Ornamental quality was evaluated according to the "Methodology for State Variety Testing of Ornamental Plants" [4] across 11 criteria: inflorescence colour and its seasonal-changes, flower size and shape, inflorescence size and density, fragrance, abundance and duration of flowering, decorative value of vegetative parts, originality, overall plant condition, and winter hardiness. The total score allowed classification of cultivars into one of three ornamental groups.

Observations were carried out at 10 representative urban greening sites (parks, squares, street-plantings, institutional grounds) representing varying levels of anthropogenic stress. At each site, at least 10 specimens of each cultivar were assessed.

3 Results

During three years of field observations (2022-2024) in the city of Saratov, ten cultivars of *H. paniculata* were evaluated: 'Pinky Winky', 'Bobo', 'Polestar', 'Selection', 'Limelight', 'Skyfall', 'Summer Love', 'Samarskaya Lydia', 'Strawberry Blossom', and 'Sundae Fraise'.

All plants were grown in ten types of urban green spaces, as listed in Table 1: parks, squares, street plantings, and institutional grounds. The highest concentration of specimens was recorded in the central districts of the city (Frunzensky, Volzhsky and Oktyabrsky), where the main recreational zones are located.

Table 1. Types of urban green spaces and locations of *Hydrangea paniculata* Siebold in Saratov.

No.	Type of green space	Location	District
1	Woody-shrub group	P.A. Stolypin Square	Frunzensky
2	Woody-shrub group	M. Gorky Central Park	Oktyabrsky
3	Woody-shrub group	Territory of the Holy Trinity Cathedral	Volzhsky
4	Solitary planting	Yu. Gagarin Park	Zavodskoy
5	Solitary planting	“Lipki” City Garden	Volzhsky
6	Flower bed	Komsomolskaya Street	Volzhsky
7	Solitary planting	“Izumrudny” (Emerald) Square	Volzhsky
8	Informal living hedge	A.P. Chekhov Street	Leninsky
9	Flower bed	Bolshaya Kazachya Street	Kirovsky
10	Flower bed	Sakko and Vanzetti Street	Frunzensky

Plant vitality, assessed using the methodology of V.S. Nikolaevskiy (Table 2), showed that 70% of the plants received the maximum score - 39-40 points, corresponding to the category “no signs of decline”. 20% of the plants (primarily those growing on Komsomolskaya Street and A.P. Chekhov Street) were classified as “moderately weakened” (32-35 points).

The remaining 10% were categorized as “slightly weakened” (36-38 points).

Table 2. Assessment of *Hydrangea paniculata* vitality in Saratov.

Evaluated parameter (mean value)	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Live shoots in crown (P1)	10±0.5	10±0.4	10±0.4	10±0.3	10±0.4	9±0.4	10±0.4	9±0.3	10±0.4	10±0.4
Crown foliage density (P2)	10±0.4	10±0.5	9±0.3	9±0.3	10±0.4	9±0.4	10±0.3	8±0.3	10±0.4	9±0.4
Live leaves in crown (P3)	10±0.4	10±0.4	10±0.4	9±0.3	10±0.4	8±0.3	10±0.4	8±0.3	9±0.4	10±0.4
Mean percentage of live leaf area (P4)	10±0.4	10±0.4	10±0.4	8±0.3	10±0.4	9±0.4	10±0.4	7±0.3	9±0.4	10±0.4
Vitality score (VS)	40±0.4	40±0.4	39±0.4	36±0.3	40±0.4	35±0.4	40±0.4	32±0.4	38±0.4	39±0.4

The distribution of plants across vitality categories is shown in Figure 1.

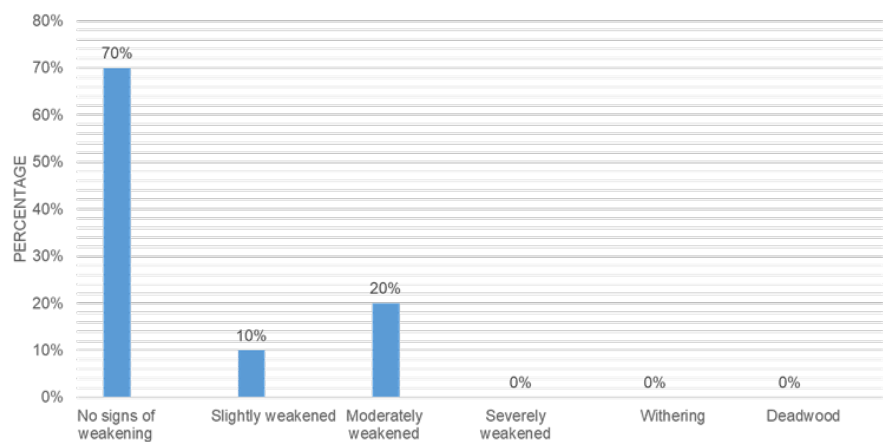


Fig. 1. Distribution of plants by vitality category.

Based on ornamental quality assessed using the methodology of M.A. Fedin (1960) (Table 3), all cultivars were divided into two groups:

- Group I (highly ornamental, 80–100 points): ‘Pinky Winky’ (85), ‘Summer Love’ (83), ‘Limelight’ (82), ‘Bobo’ (80);
- Group II (ornamental, 50–79 points): ‘Sundae Fraise’ (76), ‘Strawberry Blossom’ (75), ‘Selection’ (75), ‘Skyfall’ (73), ‘Samarskaya Lydia’ (71), ‘Polestar’ (66).

Table 3. Ornamental assessment of *Hydrangea paniculata* Siebold cultivars.

Cultivar	FCI	FS	FF	ISD	FR	AB	DF	VF	OR	PS	HW	Total	OG
Bobo	12	2	3	12	2	10	15	10	4	5	5	80	I
Limelight	16	3	2	12	2	10	15	10	2	5	5	82	I
Pinky Winky	20	3	3	12	3	8	15	8	3	5	5	85	I
Polestar	8	2	2	9	3	10	12	6	5	4	5	66	II
Samarskaya Lydia	16	3	2	6	2	10	15	8	3	4	5	71	II
Selection	12	2	2	12	2	10	15	8	2	5	5	75	II
Skyfall	8	3	3	12	2	10	12	10	4	5	4	73	II
Strawberry blossom	16	3	2	15	3	6	12	8	2	4	4	75	II
Summer Love	20	2	2	15	2	8	12	10	2	5	5	83	I
Sundae Fraise	16	3	2	12	3	8	12	8	2	5	5	76	II

Note: FCI - Flower and inflorescence colour intensity and colour change; FS - Flower size; FF - Flower form; ISD - Inflorescence size, shape, and density; FR - Fragrance: intensity and specificity; AB - Abundance of flowering; DF - Duration of flowering; VF - Vegetative foliage decorativeness; OR - Originality; PS - Plant condition; HW - Winter hardiness; Σ -Total score; OG - Ornamental group: I - highly ornamental, II - ornamental, III - less ornamental.

The highest score for inflorescence colour (20 points) was awarded to ‘Pinky Winky’ and ‘Summer Love’, which exhibit a three-tone colour transition from white to deep pink or purple. The lowest score (8 points) was given to ‘Polestar’ and ‘Skyfall’, which display a two-tone, pale pink or light green inflorescence colouration.

All cultivars received 2-3 points for flower size and form, indicating non-double, typical

petal morphology. The maximum score for inflorescence size and density (15 points) was achieved by ‘Summer Love’ and ‘Strawberry Blossom’ (inflorescences up to 35 cm). The lowest score (6 points) was recorded for ‘Samaraskaya Lydia’ (inflorescences up to 15 cm).

Fragrance intensity was weak or very weak across all cultivars (2-3 points), with the most pronounced scent observed in ‘Sundae Fraise’.

Most cultivars scored 10 points for flowering abundance (80-100% crown coverage with inflorescences). Exceptions included ‘Strawberry Blossom’ (6 points, ~50% coverage) and ‘Pinky Winky’, ‘Summer Love’, and ‘Sundae Fraise’ (8 points, 60-80% coverage).

Flowering duration exceeded 70 days in ‘Bobo’, ‘Limelight’, ‘Pinky Winky’, ‘Samaraskaya Lydia’, and ‘Selection’ (15 points). In the remaining cultivars, flowering lasted up to 70 days (12 points). The longest flowering period was observed in ‘Limelight’ (mid-July to mid-October). For vegetative decorativeness, the highest score (10 points) was assigned to ‘Bobo’, ‘Limelight’, ‘Skyfall’, and ‘Summer Love’ due to their rigid, non-bending shoots. The lowest score (6 points) was given to ‘Polestar’.

Winter hardiness was rated as high (5 points) for most cultivars. A reduced score (4 points) was assigned to ‘Skyfall’ and ‘Strawberry Blossom’ due to partial dieback of annual shoots (>50%).

The final ornamental assessment of the cultivars is presented in Figure 2.

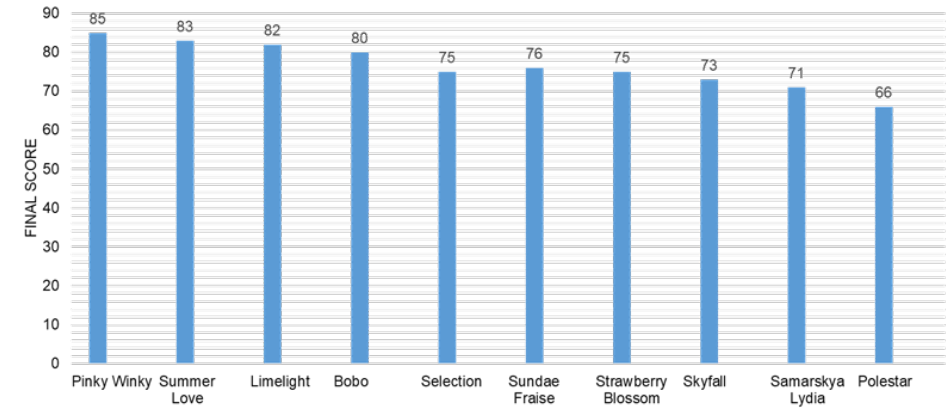


Fig. 2. Final ornamental assessment of *Hydrangea paniculata* Siebold cultivars.

4 Discussion

The obtained data confirm the high adaptability of most *H. paniculata* cultivars to the urban environment of Saratov, located in the forest-steppe zone of the Volga region with a moderately continental climate (mean annual temperature +6.8 °C, annual precipitation 480-520-mm). More than 70% of the plants demonstrated vitality scores of 39-40 points on Nikolaevskiy's scale, indicating successful acclimatization even under conditions of significant anthropogenic stress and low atmospheric humidity.

The most resilient and ornamental cultivars were ‘Pinky Winky’, ‘Summer Love’, ‘Limelight’, and ‘Bobo’. Their high scores (80-85 points) resulted not only from their three-tone inflorescence colouration and prolonged flowering (>70 days), but also from excellent foliage retention and shoot rigidity. These findings align with Dirr (2004), who notes the broad climatic adaptability of these cultivars across USDA zones 5-8. However, unlike observations in milder climates where full winter hardiness is typical [5, 6], ‘Skyfall’ and ‘Strawberry Blossom’ exhibited significant dieback of annual shoots (>50%) under Saratov conditions. This is likely due to the combination of early autumn frosts, snow-poor winters, and late spring cold snaps typical of the Volga region [7].

Notably, ornamental value does not always correlate with vitality. For example, ‘Polestar’, despite its original rounded inflorescences and salmon hue, received a low overall score (66 points) due to loose panicle structure, shoot flexibility, and partial winter injury. This aligns with the general principle of plant stress physiology: under adverse conditions such as drought [8], heat, or pollution, resources are preferentially allocated to survival mechanisms rather than ornamental traits [9]. Dense inflorescences and rigid shoots observed in top-performing cultivars may indicate elevated lignin and cellulose synthesis key components of mechanical resilience.

Particular attention should be paid to the microclimate of urban planting sites. Plants on Komsomolskaya Street and A.P. Chekhov Street (areas with high impervious surface coverage, low soil moisture, and strong wind exposure) showed reduced vitality (32-35 points). In contrast, those in M. Gorky Central Park and P.A. Stolypin Square – with regular irrigation and wind protection-achieved maximum scores. This underscores that successful urban greening depends not only on cultivar selection but also on landscape architectural context [10].

The practical significance of this study lies in enabling differentiated use of cultivars:

- Highly ornamental and resilient (‘Pinky Winky’, ‘Limelight’) are recommended for central parks, avenues, and solitary plantings;
- Compact and moderately ornamental (‘Bobo’, ‘Summer Love’) are ideal for small-scale landscaping (patios, balconies, borders);
- Original but less hardy (‘Polestar’, ‘Skyfall’) should be used only in sheltered microsites with enhanced agronomic care (spring pruning, mulching, winter protection).

It should be noted that a three-year observation period allows only preliminary conclusions.

Final assessment of winter hardiness, longevity, and response to extreme weather events (e.g., the 2024 drought) requires monitoring over 5-7 years. Furthermore, future studies should complement visual assessment with physiological methods: leaf water potential, photosynthetic rate, and pigment content measurements this would deepen understanding of adaptation mechanisms.

Nevertheless, at this stage it can be confidently stated that *H. paniculata* is a promising species for sustainable urban greening in the Volga region [8], especially when cultivars are carefully selected and microclimatic conditions of planting sites are taken into account.

5 Conclusion

The three-year study confirmed the high adaptability of *H. paniculata* Siebold to the urban conditions of Saratov and enabled the identification of cultivars most promising for use in urban greening. Four cultivars – ‘Pinky Winky’, ‘Summer Love’, ‘Limelight’, and ‘Bobo’ – demonstrated not only the highest ornamental value (80–85 points) but also excellent vitality (3-40 points), making them suitable for parks, avenues, and solitary plantings. In contrast, ‘Skyfall’ and ‘Strawberry Blossom’ exhibited reduced winter hardiness, with more than 50% dieback of annual shoots, and therefore require winter protection under Volga region conditions. The study also revealed that ornamental quality does not always correlate with vitality: distinctive cultivars such as ‘Polestar’ may be less resilient due to weak shoot mechanical strength and low inflorescence density. These findings support a differentiated approach to selecting *H. paniculata* cultivars – taking into account green space type, local microclimatic conditions, and available horticultural maintenance – when designing urban plantings in the forest-steppe zone of the Volga region.

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References

1. D.E. Pataki, *Grand challenges in urban ecology*. Front Ecol Environ, **13**, 3 (2015)
2. J.W. Thompson, K. Sorvig, *Sustainable Landscape Construction: A Guide to Green Building Outdoors*. Washington: Island Press (2008)
3. V.S. Nikolaevskiy, *Methods for assessing the condition of woody plants and the degree of impact of adverse factors*. in Lesnoe Khozyaistvo (Forestry), **4** (1975)
4. *Methodology for State Variety Testing of Ornamental Plants*. Ministry of Agriculture of the RSFSR (1960)
5. M.A. Dirr, *Hydrangeas for American Gardens*. Portland: Timber Press (2004)
6. O.M. Lindstrom, M.A. Dirr, *Cold Hardiness of Hydrangea paniculata Cultivars*. J Environ Hort, **28**, 2 (2010)
7. P.I. Lapin, L.V. Sidneva, *Frost Hardiness of Woody Plants in Cities of the European Part of the USSR*. Moscow: Nauka (1975)
8. M.C. Diaz-Barradas, J.B. Gallego-Fernández, M. Zunzunegui, *Leaf functional traits and physiological responses of urban shrubs to drought and pollution*. Environ Exp Bot, **182** (2021)
9. K.J. Niklas, *Plant Biomechanics: An Engineering Approach to Plant Form and Function*. Chicago: University of Chicago Press (1992)
10. P. Oudolf, N. Kingsbury, *Planting: A New Perspective*. Portland: Timber Press (2013)