

Article

Seasonal Dynamics of Functional and Ornamental Performance of Nine Perennial Taxa in an Established Urban Planting

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Abstract

Herbaceous perennials contribute to the functional stability and ornamental quality of urban plantings, but these dimensions are rarely assessed together. This study evaluated nine perennial taxa in an established municipal planting in southern Poland. During a 370-day period fortnightly observations documented canopy development, flowering, foliage persistence, winter interest, overwintering and stand retention. Ten performance indicators were calculated and taxon profiles were compared using hierarchical cluster analysis. Canopy Closure Time ranged from 43 days in *Rudbeckia fulgida* ‘Goldsturm’ to 109 days in *Imperata cylindrica* ‘Red Baron’, whereas *Echinacea purpurea* ‘Golden Skipper’ did not achieve complete canopy closure. All other taxa showed 100% overwintering and stand retention; the values for *E. purpurea* ‘Golden Skipper’ were 67% and 11%. *R. fulgida* ‘Goldsturm’ and *Miscanthus sinensis* ‘Silberspinne’ achieved the highest Flowering Effect, while *M. sinensis* ‘Silberspinne’ and *Panicum virgatum* ‘Shenandoah’ had the highest Structural Value. Ornamental Continuity was greatest in *R. fulgida* ‘Goldsturm’ and *E. purpurea* ‘Golden Skipper’, despite the poor persistence of the latter. Four clusters differentiated taxa according to canopy stability, flowering, persistent structure, and seasonal foliage effects. Within the studied perennial planting, functional stability and ornamental continuity arose from different trait combinations, suggesting complementary roles among the evaluated taxa.

Keywords: perennial plants; seasonal development; functional performance; ornamental performance; stand persistence; ornamental continuity; sustainable planting design

1. Introduction

Herbaceous perennials play an increasingly important role in contemporary garden art and urban landscape. Their longevity, structural diversity and pronounced seasonal variability make them essential components of planting schemes in public spaces. The growth and flowering dynamics of perennials throughout the vegetation season are therefore not only a subject of botanical and ecological research, but also a key design consideration in the creation of resilient, expressive and sustainable urban green spaces [1,2]. In garden and landscape design the temporal dimension of planting is of particular importance. Perennials undergo continuous changes in form, texture and color during the growing season. Their emergence, vegetative growth, flowering and senescence collectively shape the visual rhythm and spatial structure of a planting composition over time [3]. A detailed understanding of these developmental phases allows designers to deliberately compose plantings that maintain aesthetic quality and spatial legibility from early spring to late



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autumn. This approach has been strongly reinforced in recent decades by the emergence of the New Perennial Movement, a design philosophy that emphasizes naturalistic planting, ecological sustainability and the expressive potential of herbaceous species. This movement positions perennials as primary design material in urban landscapes, valuing not only peak flowering but also structure, seed heads and seasonal change [4,5]. For decorative perennials of regional flora, the length and rhythm of vegetation are used as the indicators of seasonal dynamics and duration of decorative effect; combining species with different flowering periods and strong vegetative aspects allows for a long, changing display through the season [6]. Landscape designers are also encouraged to plan perennial plantings using species with different flowering times and seasonal changes in plant colour and appearance. Such an approach can create temporal variation in the visual character of a planting and provide dynamic ornamental interest throughout the growing season [7]. Within this context, knowledge of species-specific growth vigour, flowering duration and seasonal variability becomes an important prerequisite for effective planting design.

Beyond their artistic and compositional value, ornamental perennials are increasingly recognized for their practical advantages in the sustainable management of urban green spaces. Numerous studies indicate that well-selected perennial combinations can perform effectively under low-maintenance regimes, contributing to reduced irrigation needs, limited weed development and long-term ground cover stability [8]. Once established, many perennial species require fewer maintenance interventions than annual plantings, which makes them particularly suitable for municipal landscapes where cost efficiency and long-term resilience are essential design criteria.

In addition to their functional and aesthetic qualities, perennial plantings play an important role in supporting urban biodiversity. Diverse assemblages of herbaceous perennials provide a continuous and seasonally varied supply of nectar and pollen, offering essential resources for pollinators such as bees, butterflies and other flower-visiting insects [9]. The staggered flowering periods typical of perennial-dominated plantings are especially valuable in urban environments, where floral resources are often fragmented and temporally limited. As a result, perennial beds can simultaneously enhance ecological resilience and enrich the experiential quality of urban public spaces.

Municipal perennial beds represent a particularly valuable setting for observing the interaction between design intent and biological processes. They combine aesthetic objectives with ecological function and practical maintenance constraints. Analyzing the seasonal development of perennials in such contexts offers insights into how growth and flowering dynamics can be consciously used as a design tool in contemporary urban landscapes [2,4].

The successful use of perennial taxa in urban plantings depends on both the ornamental effects they provide over the course of the year and their ability to establish and persist under local growing conditions. Rapid ground coverage and stand persistence contribute to the spatial completeness and long-term stability of a planting, whereas flowering, foliage, plant structure and winter interest shape its seasonal visual quality and influence how such plantings are perceived by the public. These represent two complementary but non-interchangeable dimensions of taxon performance relevant to contemporary perennial planting design. Consequently, assessments based solely on plant survival or flowering provide only a partial picture of taxon performance within a planting [8,10,11].

Previous studies have evaluated selected components of perennial landscape performance, including flowering phenology, plant growth and ground coverage, winter survival and visual quality [8,12–14]. However, much of this evidence comes from studies of individual genera or from purpose-designed experimental plantings and trial gardens [12–15]. Other studies have focused on specialized urban planting systems including rain gardens, green roofs and living walls [16–19]. Only a few studies have examined perennial plant-

ings already established in public parks or municipal flower beds [2,20], and these did not integrate taxon-level functional and ornamental performance over a complete annual cycle. Consequently, evidence remains limited on the combined functional and ornamental performance of established perennial taxa monitored throughout the growing season and the subsequent winter under the routine conditions of a municipal public planting.

Urban environmental conditions shape the growth and flowering dynamics of perennial plants. Climatic factors, soil properties and site exposure strongly influence plant performance and visual expression. The study area presented here, located in Gmina Babice in Chrzanów County (Lesser Poland Voivodeship), is characterized by a temperate continental climate with distinct seasonal variation, moderate precipitation and soils typical of southern Poland [21]. These inland conditions differ substantially from maritime or coastal climates and therefore provide a relevant context for examining perennial development in municipal planting schemes.

The aim of this study was to assess the seasonal development and functional and ornamental performance of nine herbaceous perennial taxa growing in an established municipal urban planting. An indicator-based approach was applied to quantify changes in canopy development, flowering, persistence and ornamental value over a 12-month observation period and to examine similarities among taxa. The main contribution of this study lies in the integrated assessment of functional and ornamental performance through two complementary year-round indicator profiles, allowing seasonal changes in these two dimensions to be evaluated separately and compared across taxa. By documenting plant performance throughout the vegetation season, the research seeks to support informed species selection and planting design strategies in urban environments, where the dynamic character of perennials plays a crucial role in both artistic expression and sustainable landscape management.

2. Materials and Methods

2.1. Study Site and Plant Material

The study was conducted in 2023 and early 2024 in the public green space at Mogielnicki Square in Babice, Lesser Poland Voivodeship, southern Poland (50°04' N, 19°26' E). The study site comprised a mixed planting of herbaceous perennials and shrubs covering approximately 0.2 ha. The planting was established in 2020 as part of the revitalisation of the square. The herbaceous perennials included in the study were planted in late autumn 2020 in a conventional block arrangement with individual taxa grouped in single-taxon drifts. The planting beds were mulched with mineral aggregate.

Nine perennial taxa were included in the study. Depending on the taxon and the number of plants available within the planting, measurements were conducted on 9–13 individuals: *Echinacea purpurea* 'Golden Skipper' (9 plants), *Hemerocallis* 'Perła Warszawy' (12), *Lythrum salicaria* 'Robin' (13), *Rudbeckia fulgida* 'Goldsturm' (9), *Salvia nemorosa* (12), *Imperata cylindrica* 'Red Baron' (10), *Miscanthus sinensis* 'Silberspinne' (11), *Panicum virgatum* 'Shenandoah' (12) and *Sesleria autumnalis* (10) (Figure 1). The plants were evaluated under the maintenance regime routinely applied at the study site. Maintenance comprised weeding and taxon-specific cutting back performed when the plants had lost their ornamental value.

The study site lies within the Dfb climate zone characterized by a cold climate with warm summers and no dry season according to the Köppen classification [22]. Data obtained from the Kraków-Balice station of the Institute of Meteorology and Water Management-National Research Institute (IMGW-PIB), the station nearest to the study site (50°05' N, 19°48' E), show that weather conditions varied considerably following planting in late 2020 (planting establishment) (Figure 2). The year 2021 was the coolest and wettest (8.9 °C; 774.9 mm), whereas 2022 was distinctly warmer and the driest (9.8 °C;

592.7 mm). In autumn 2022 a relatively cool September was followed by a milder and drier October. During the winter of 2022/2023 air temperature fell to -13.9°C and ground-level temperature to -17.6°C , with the lowest values recorded in December 2022 and February 2023. The year 2023, which constituted the main observation season, was warm and relatively wet. The mean annual air temperature was 10.4°C and the annual precipitation total reached 751.7 mm. Days with minimum air temperatures below 0°C still occurred in March and April, whereas no frost was recorded from May to September. The summer was warm with the highest monthly precipitation total recorded in August (100.8 mm). September and October were particularly warm with mean air temperatures of 17.7 and 11.5°C , respectively, resulting in a long and mild autumn. The first autumn frosts occurred in October. During the winter of 2023/2024 the most severe frost occurred in January 2024, when air temperature fell to -18.4°C and ground-level temperature to -21.5°C . Isolated days with minimum air temperatures below 0°C continued to occur until the end of the observation period on 26 March 2024.



Figure 1. Herbaceous perennial taxa evaluated in the study: (1) *Echinacea purpurea* 'Golden Skipper' (Asteraceae); (2) *Hemerocallis* 'Perla Warszawy' (Asphodelaceae); (3) *Lythrum salicaria* 'Robin' (Lythraceae); (4) *Rudbeckia fulgida* 'Goldsturm' (Asteraceae); (5) *Salvia nemorosa* (Lamiaceae); (6) *Imperata cylindrica* 'Red Baron' (Poaceae); (7) *Panicum virgatum* 'Shenandoah' (Poaceae); (8) *Miscanthus sinensis* 'Silberspinne' (Poaceae); (9) *Sesleria autumnalis* (Poaceae).

2.2. Data Collection

Data collection and field observations were carried out from 22 March 2023 to 26 March 2024 (a 370-day observation period) by a single observer, during the third growing season after planting establishment. Observations were conducted at approximately two-week intervals and included the following biometric measurements: plant height and diameter, leaf length, and flower/inflorescence size (diameter or length) and number. Plant height was measured vertically from ground level to the highest point of the plant at each observation date, irrespective of whether this point was formed by leaves, leafy shoots or flowering shoots with flowers/inflorescences. Plant diameter was measured horizontally across the upper part of the plant. To maintain consistency throughout the observation period, all field observations and measurements were performed by the same observer using the predefined criteria described in Table 1 and Appendix A at each observation date.

Depending on plant morphology, flower/inflorescence length or diameter and color impact were recorded. Based on successive observations total flowering period (TF) and full flowering period (FF) were determined. TF was defined as the total number of days during which open flowers were present or, in ornamental grasses, fresh, fully emerged, and non-senescent inflorescences were observed. TF began on the first observation date on

which these features were recorded and ended on the first subsequent observation date on which they were no longer present. Persistent dry or discoloured inflorescences were excluded. For taxa flowering in separate episodes, the durations of the individual flowering periods were calculated separately and then summed. The FF period was defined as the period in which the number of open flowers or fresh, fully developed inflorescences on the plant reached at least 75% of the seasonal maximum. In addition, foliage condition, structural appearance and post-season ornamental effects were recorded at each observation date. Planting spacing was measured from the centre of each plant to the centre of the adjacent plant. The number of plants that survived the winter of 2023/2024 was recorded in spring 2024. Additionally, prior to the start of the observations, the number of individuals originally planted in 2020 was determined for each taxon from the available planting design documentation.

Photographic documentation was collected at approximately two-week intervals throughout the observation period. All photographs were taken by the same observer from the same viewpoint to ensure consistency in the photographic documentation of seasonal changes in plant growth, flowering, foliage condition, structural appearance and post-season ornamental effects. The photographs were arranged chronologically into photographic plates illustrating changes over the 12-month period. Photographic plates for two randomly selected taxa are presented as examples in the main text (Figures 3 and 4), while those for the remaining taxa are provided in the Supplementary Materials.

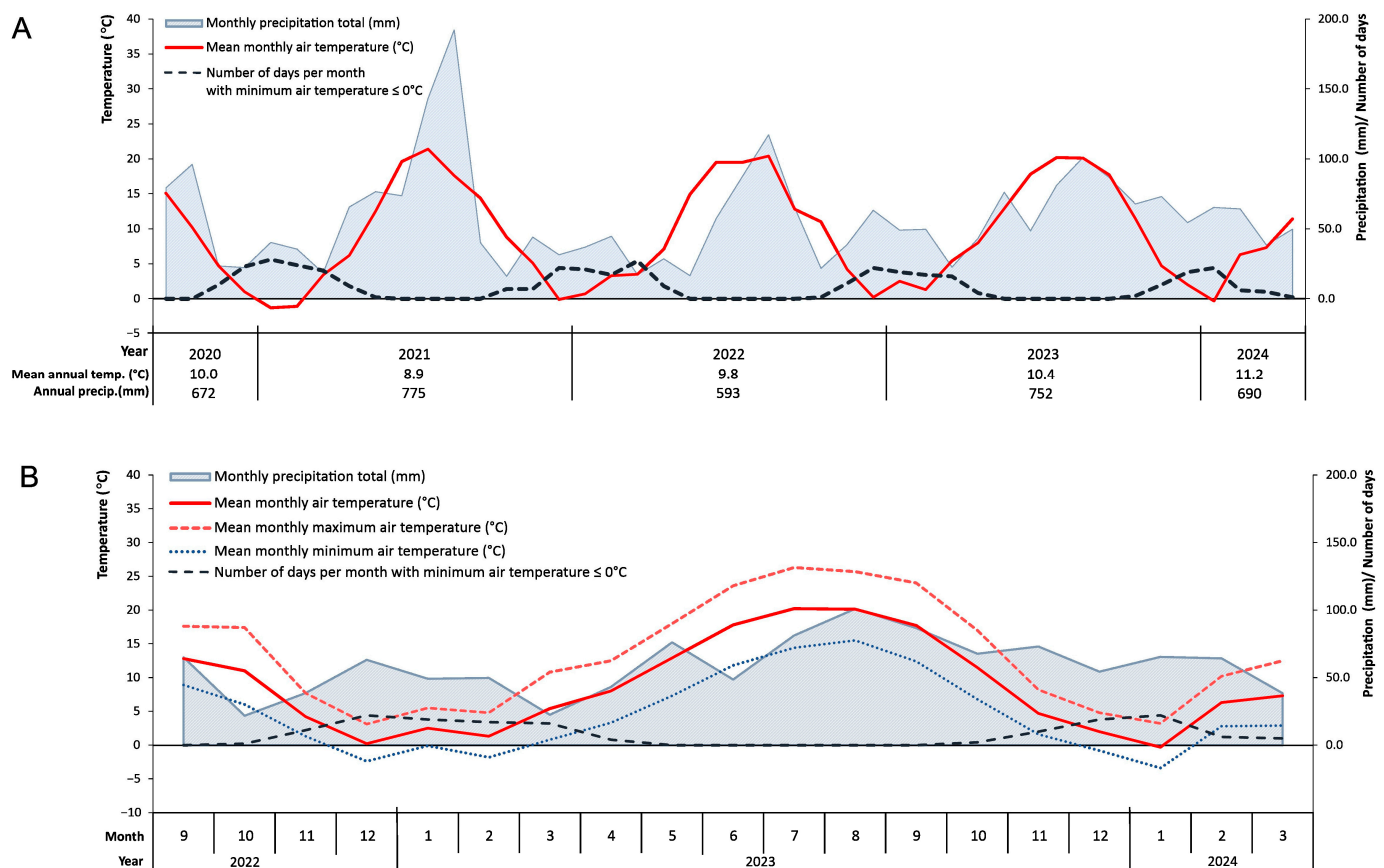


Figure 2. Weather conditions for study site: (A) monthly precipitation totals, mean monthly air temperature, and number of days per month with minimum air temperature $\leq 0^{\circ}\text{C}$ from September 2020 to March 2024; mean annual air temperatures and annual precipitation totals for the complete calendar years are shown below the panel. (B) Detailed weather conditions from September 2022 to March 2024, including mean monthly minimum and maximum air temperatures.

Table 1. Measures and indicators used to assess the functional and ornamental performance of the evaluated perennial taxa. (FF)—full flowering period.

Measure or Indicator	Definition and Interpretation	Calculation
Functional profile		
Relative Plant Spread (C_t , %)	Describes the extent to which plants filled the space between neighbouring plants at observation date (t). A value of 100% indicated full closure between neighbouring plants, corresponding to complete canopy cover; values above 100% indicated overlap between neighbouring plants; and values below 100% indicated that complete canopy cover had not been achieved.	At each observation date, C_t was calculated as: $C_t = \frac{\text{plantspread diameter at time } t(\text{cm})}{\text{initial centre-to-centre planting spacing}(\text{cm})} \times 100$
Canopy Closure Time (CCT, days)	Describes the time to first full closure between neighbouring plants at the applied planting spacing. Expressed in days; lower values indicate faster closure.	CCT was calculated as the number of days between the first observation date common to all taxa (t_0) and the first observation date at which Relative Plant Spread C_t reached or exceeded 100% (t_{100}): $\text{CCT} = t_{100} - t_0$
Canopy Closure Persistence (CCP, %)	Describes the duration of full closure between neighbouring plants at the applied planting spacing. Higher values indicate that closure was maintained for longer.	CCP was calculated as the number of days during which C_t was equal to or greater than 100%, divided by the number of days in the observation period common to all taxa. To exclude the effect of selective winter cutting, CCP was calculated over the common period from 23 March to 6 December 2023 (259 days): $\text{CCP} = \frac{\text{number of days with } C_t \geq 100\%}{\text{number of days in the CCP observation period (259 days)}} \times 100$
Annual Clump Retention (ACR, %)	Describes the change in mean clump diameter between the beginnings of two successive growing seasons. A value of 100% indicates unchanged clump diameter; values above 100% indicate expansion, whereas values below 100% indicate a reduction.	ACR was calculated by dividing the mean clump diameter measured at ground level at the beginning of the second growing season by that recorded at the beginning of the first growing season: $\text{ACR} = \frac{\text{mean clump diameter on March 2024}}{\text{mean clump diameter on March 2023}} \times 100$
Overwintering Rate (OWR, %)	Describes the proportion of plants that resumed growth in spring 2024 relative to the number present before the winter of 2023/2024. Higher values indicate greater overwintering success under local conditions.	OWR was calculated as: $\text{OWR} = \frac{\text{number of plants that resumed growth in spring 2024}}{\text{number of plants present before the winter of 2023/2024}} \times 100$

Table 1. Cont.

Measure or Indicator	Definition and Interpretation	Calculation
Plant Stand Retention (PSR, %)	Describes the proportion of plants from the original planting established in 2020 that remained present in 2023. Higher values indicate greater long-term stand persistence.	PSR was calculated as: $PSR = \frac{\text{number of plants from the original planting remaining in 2023}}{\text{number of plants originally planted in 2020}} \times 100$
Ornamental profile		
Flowering Effect (FIE, %)	Provides a combined assessment of the overall visual effect of flowering based on flower or inflorescence abundance, colour impact and the duration of total and full flowering. A score of 0 indicates the absence of the respective flowering component. Higher component scores indicate a stronger and longer-lasting flowering effect.	FIE was calculated from four equally weighted components: the maximum number of simultaneously open flowers or fresh inflorescences per plant (N), colour impact (CI), total flowering period (TF) and full flowering period (FF). Depending on species morphology, individual flowers or entire inflorescences were counted. Each component was scored from 0 to 4 using the criteria presented in Table A1. The score ranges for N, TF, and FF were based on the values recorded across all evaluated taxa, whereas CI was assessed using the visual categories defined in Appendix A. FIE was calculated as: $FIE = \frac{\text{score for } N + \text{score for } CI + \text{score for } TF + \text{score for } FF}{16} \times 100$
Foliage Effect (FoE, %)	Describes the duration of the ornamental effect provided by fresh, living foliage during the observation cycle. Higher values indicate greater seasonal persistence of the foliage effect.	FoE was defined as the duration of the period during which plants retained fresh, living foliage, expressed as a percentage of the 370-day observation period. Fresh foliage included non-dried leaves retaining the colour characteristic of the taxon, including natural seasonal colour changes. A taxon was considered to retain living foliage when at least 50% of the visible foliage remained fresh and non-dried. Plants were cut back only after the foliage had lost its visual attractiveness; therefore, cutting was considered to mark the end of the fresh-foliage period. FoE was calculated as follows: $FoE = \frac{\text{number of days with fresh, living foliage}}{\text{number of days in the full observation period (370 days)}} \times 100$

Table 1. Cont.

Measure or Indicator	Definition and Interpretation	Calculation
Winter Interest Effect (WIE, %)	Describes the duration of the post-growing-season ornamental effect provided by persistent foliage, shoots, generative structures or a distinct plant silhouette that remained visually attractive. Higher values indicate a longer-lasting winter ornamental effect.	WIE was defined as the duration of the post-growing-season ornamental effect, expressed as a percentage of the full 370-day observation period. For each taxon, the beginning of this period was defined as the date of the first documented observation after the end of active growth or the main seasonal ornamental effect at which a visually attractive post-growing-season form was recorded. The end of this period was defined as the date of the last documented observation at which this effect remained visible, before the plant lost its distinct form, was cut back, or showed clear spring regrowth. WIE was calculated as follows: $\text{WIE} = \frac{\text{number of days with a post – growing season ornamental effect}}{\text{number of days in the full observation period (370 days)}} \times 100$
Structural Value (SV, %)	Describes the plant's ability to create and maintain a distinct spatial structure within the planting. Structural value is assessed in relation to the accompanying plants from the same taxa group. Higher SV values indicate a greater structural contribution to the planting composition.	SV was determined from four equally weighted components: relative scale and spatial prominence (SP), distinctiveness of growth habit and shoot architecture (AR), integrity of structural form and resistance to lodging (IR), and seasonal duration of the structural effect (SD). Each component was scored from 0 to 4 using the criteria presented in Table A2. Scores were assigned based on biometric measurements and field observations. SV was calculated as follows: $\text{SV} = \frac{\text{scoreforSP} + \text{scoreforAR} + \text{scoreforIR} + \text{scoreforSD}}{16} \times 100$
Ornamental Continuity (OC, %)	Describes the proportion of the observation period during which the plant exhibited at least one clearly perceptible ornamental effect. Higher OC values indicate greater temporal continuity of the plant's ornamental contribution.	OC was determined as the total number of days during which a taxon exhibited at least one clearly perceptible ornamental effect derived from foliage, flowering, persistent generative structures or structural form. The beginning and end of each effect were determined from successive field observations. Periods in which two or more ornamental effects overlapped were counted only once, regardless of their number or intensity. OC was expressed as a percentage of the entire 370-day observation period and calculated as follows: $\text{OC} = \frac{\text{number of days with at least one ornamental effect}}{\text{number of days in the full observation period (370 days)}} \times 100$

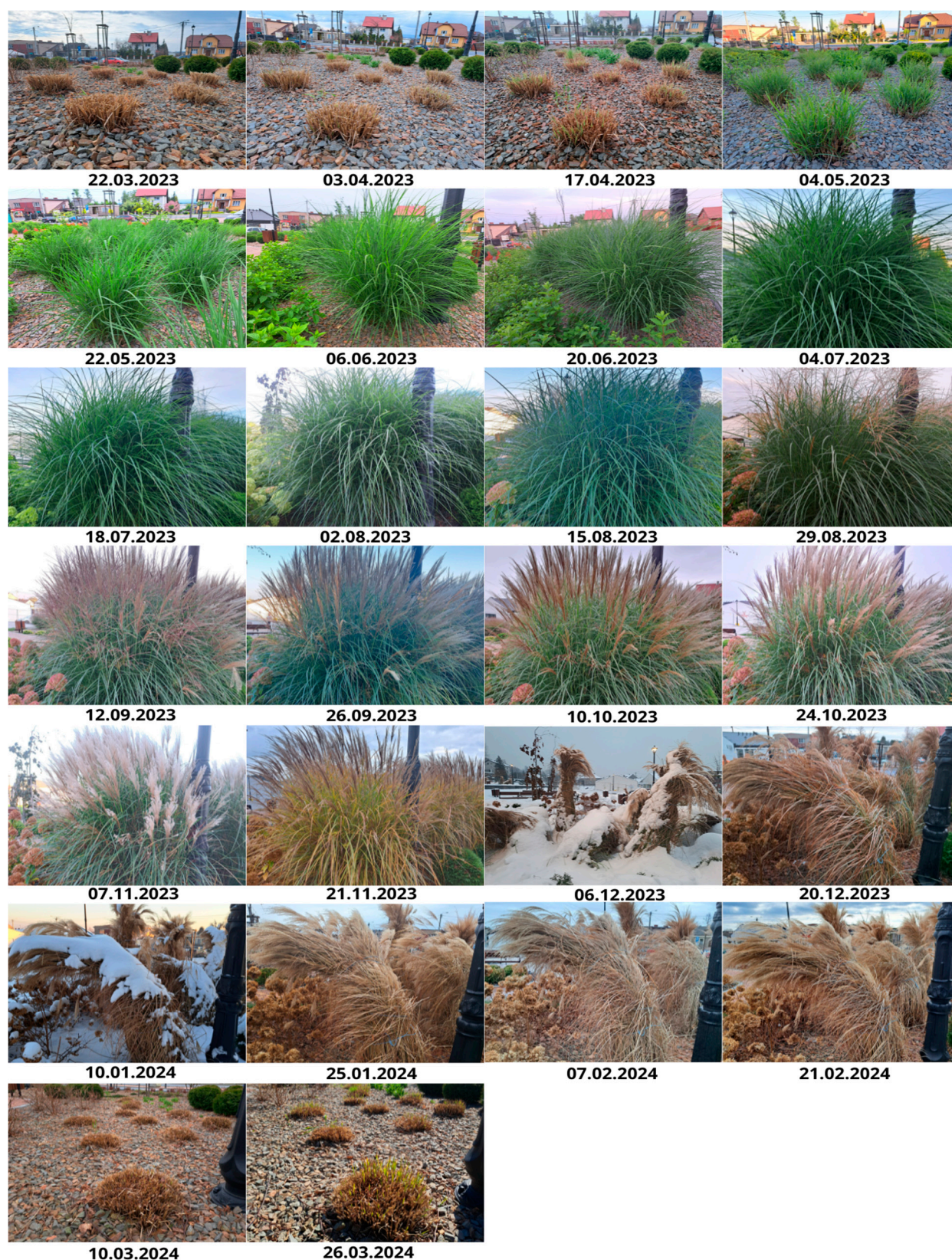


Figure 3. Seasonal changes in the appearance of *Miscanthus sinensis* ‘Silberspinne’ over the 12-month observation period, documented by chronologically arranged photographs. Dates below the photographs indicate the observation dates.

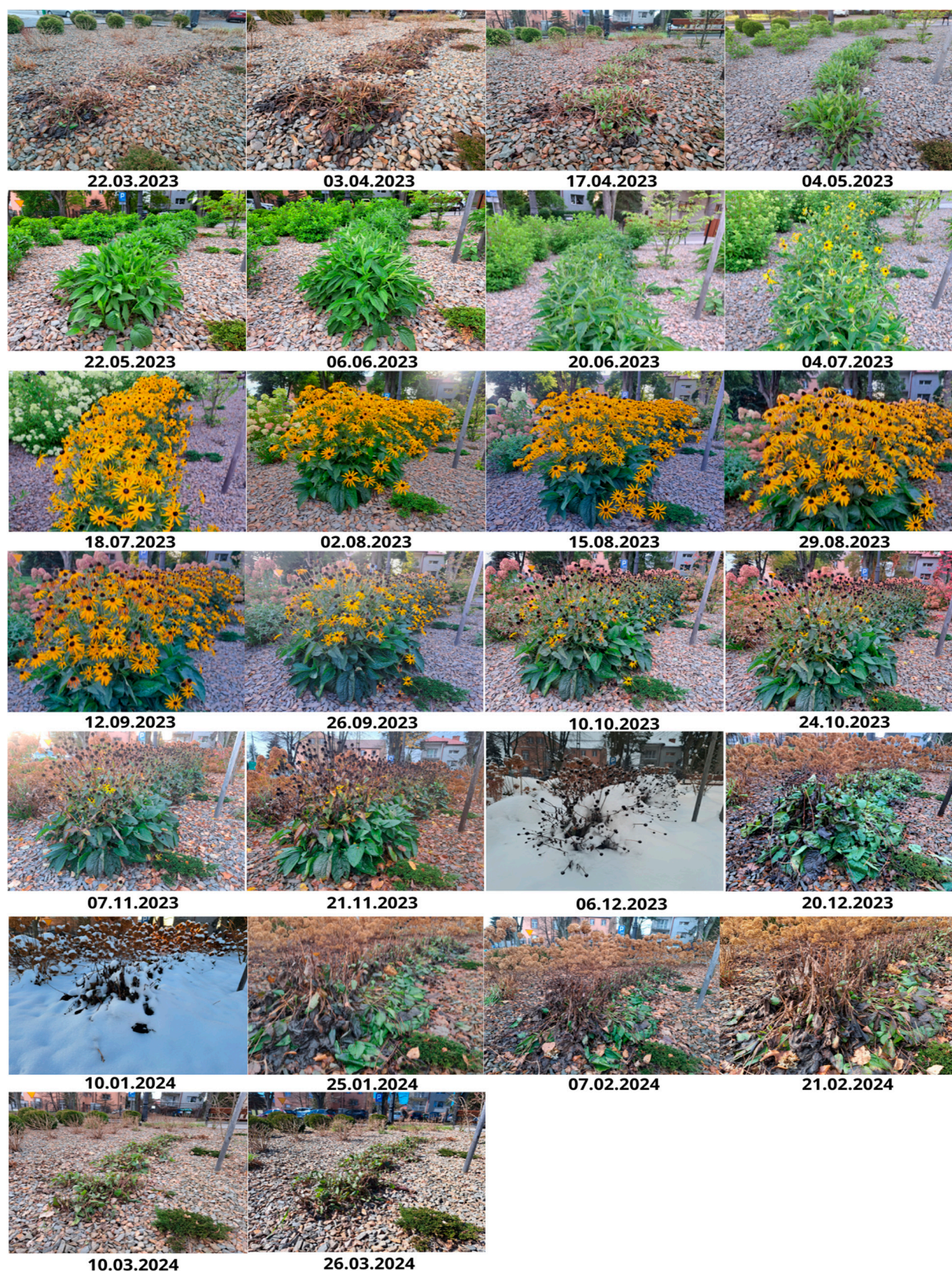


Figure 4. Seasonal changes in the appearance of *Rudbeckia fulgida* 'Goldsturm' over the 12-month observation period, documented by chronologically arranged photographs. Dates below the photographs indicate the observation dates.

2.3. Data Processing

To address the study objectives, biometric measurements and visual assessments recorded for individual plants were averaged within taxa at each observation date. These data were then used to derive a set of measures and indicators organized into two profiles: functional and ornamental. The two profiles were retained as distinct dimensions of plant performance rather than combined into a single overall score.

The functional profile described the ability of each taxon to occupy and retain the available planting space, maintain its clump size between years, survive the winter and persist within the planting. The profile comprised Relative Plant Spread (C_t) calculated for each observation date and five indicators: Canopy Closure Time (CCT), Canopy Closure Persistence (CCP), Annual Clump Retention (ACR), Overwintering Rate (OWR) and Plant Stand Retention (PSR).

The ornamental profile encompassed flowering intensity and duration; the persistence of living foliage; the distinctiveness, integrity and seasonal persistence of plant form; post-growing-season interest and the continuity of ornamental effects throughout the observation period. The profile comprised five indicators: Flowering Effect (FIE), Foliage Effect (FoE), Winter Interest Effect (WIE), Structural Value (SV) and Ornamental Continuity (OC).

The definitions, calculation procedures, units and interpretation of the measures and indicators included in both profiles are summarized in Table 1. Detailed scoring criteria for the components of ornamental profile indicators are provided in Appendix A.

2.4. Statistical Analysis

Biometric and flowering data were analysed using descriptive statistics. For each taxon and observation date, arithmetic means were calculated from measurements of each individual plant and seasonal maxima were defined as the highest of these date-specific means.

An exploratory hierarchical cluster analysis using Ward's method and squared Euclidean distance was performed to identify similarities among taxa in functional and ornamental performance. The analysis was performed in Statistica 13.3 (TIBCO Software Inc., Palo Alto, CA, USA) using unstandardized indicator values expressed on broadly comparable 0–100 scales. CCT was included as an inverted score rather than as the original value in days, so that higher values consistently represented more favourable performance across all variables. The number of clusters was determined by examining the dendrogram and the agglomeration schedule. The resulting cluster structure was presented as a dendrogram and interpreted together with a heat map. For the heat map, z-scores were calculated separately for each indicator across taxa.

3. Results and Discussion

3.1. Seasonal Growth and Flowering Characteristics

The evaluated taxa showed a wide range of plant dimensions (Table 2). Maximum mean height ranged from 52 cm in *Echinacea purpurea* 'Golden Skipper' to 200 cm in *Miscanthus sinensis* 'Silberspinne' (Figure 3), while maximum mean spread ranged from 44 to 210 cm in the same taxa.

Eight of the nine evaluated taxa flowered during the observation period (Table 2). Observed flowering periods varied widely in their timing and duration. The earliest onset of flowering was recorded for *Salvia nemorosa* on 20 May, whereas *M. sinensis* 'Silberspinne' remained in flower until 7 November. *Rudbeckia fulgida* 'Goldsturm' (Figure 4) had the longest uninterrupted observed flowering period extending from 4 July to 24 October. Both *Lythrum salicaria* 'Robin' and *S. nemorosa* resumed flowering after an interruption, whereas *Imperata cylindrica* 'Red Baron' did not flower during the observation period. The

absence of flowering observed in *Imperata cylindrica* ‘Red Baron’ during the observation period is consistent with previous reports suggesting that this cultivar is putatively sterile. Its ornamental value is considered to be primarily associated with its red-colored leaves rather than flowering [23]. Despite this, the different flowering periods of the remaining taxa overlapped and complemented one another, resulting in a relatively continuous floral display over a substantial part of the growing season. The early flowering of *S. nemorosa*, the prolonged flowering of *R. fulgida* ‘Goldsturm’, the renewed flowering of *L. salicaria* ‘Robin’ and *S. nemorosa* and the late-season flowering of *M. sinensis* ‘Silberspinne’ suggest effective temporal complementarity among the taxa. Such temporal complementarity in flowering phenology can be an important principle in perennial planting design, as the selection and combination of species with complementary phenological traits extend the period of flowering and increase the visual value of designed plant communities [13]. In the case of *I. cylindrica* ‘Red Baron’, its contribution to the composition derives from distinctive foliage. This is consistent with the broader principle of maintaining seasonal ornamental interest through sustainable urban planting design, in which flowering is considered alongside foliage colour and other plant attributes contributing to visual interest throughout the growing season [24–26].

3.2. Functional and Ornamental Performance Indicators

To provide a broader assessment of planting performance, this study applied a set of complementary indicators. Together, these indicators capture aspects of planting performance that are not fully reflected by individual measures.

The time required to reach complete canopy cover ($C_t \geq 100\%$) differed among the evaluated taxa (Table 3, Figure 5). At the planting spacings used, *Rudbeckia fulgida* ‘Goldsturm’ and *Hemerocallis* ‘Perla Warszawy’ reached complete canopy cover most rapidly with CCT values of 43 and 44 days respectively. Most of the remaining taxa reached this threshold within 53–66 days, whereas *Imperata cylindrica* ‘Red Baron’ required 109 days. A similar seasonal pattern was reported for *Imperata cylindrica* under Central European climatic conditions, with slow spring regrowth followed by improved performance later in the growing season [27]. *Echinacea purpurea* ‘Golden Skipper’ did not achieve complete canopy cover during the observation period (maximum $C_t = 78\%$) and consequently had a CCP value of 0%. *Rudbeckia fulgida* ‘Goldsturm’ and *Hemerocallis* ‘Perla Warszawy’ also had the highest CCP values (83.4% and 83.0%, respectively), reflecting not only their relatively early resumption of growth in spring but also their prolonged foliage retention. In contrast, among the taxa that reached complete cover, *I. cylindrica* ‘Red Baron’ had the lowest CCP (41.3%), due to its delayed canopy development and early autumn leaf senescence. CCT and CCP provide complementary information. CCT indicates how rapidly complete canopy cover is achieved at the planting spacing used, whereas CCP expresses how long this cover is maintained. CCT is therefore particularly relevant to planting design because it relates plant expansion directly to the actual spacing between neighbouring plants. However, rapid canopy closure alone does not ensure persistent soil cover. A taxon may achieve complete cover early but lose it later in the growing season. CCP is particularly valuable in this respect, as it distinguishes taxa that maintain complete cover for most of the observation period from those whose cover is only temporary. In urban perennial plantings, rapid and persistent canopy closure may protect the soil surface from excessive heating and evaporative water loss and may also restrict weed establishment [28,29]. Pomatto et al. [8] similarly found that the perennial combination maintaining the most constant ground cover over three years also showed the strongest weed containment, whereas high cover during the first year did not necessarily ensure sustained performance in subsequent years.

Table 2. Summary of the main seasonal growth and flowering characteristics of the evaluated perennial taxa in 2023. Values represent the highest mean recorded across successive observation dates for the number of plants indicated for each taxon.

Taxon	Maximum Height (cm; Date ¹)	Maximum Spread Diameter (cm; Date)	Maximum Flower/ Inflorescence Size ² (cm)	Maximum Number of Simultaneously Open Flowers/Fresh Inflorescences (no. per Plant; Date)	Flowering Period (s) ³	Planting Spacing (cm)
<i>Echinacea purpurea</i> ‘Golden Skipper’	52; 29 August	44; 18 July	11 (D)	12; 2 August	20 June–29 August	60
<i>Hemerocallis</i> ‘Perła Warszawy’	83; 4 July	117; 20 June	23 (D)	33; 18 July	4 July–2 August	55
<i>Lythrum salicaria</i> ‘Robin’	133; 4 July	95; 20 June	42 (L)	78; 4 July	20 June–18 July; 15 August–12 September	55
<i>Rudbeckia fulgida</i> ‘Goldsturm’	78; 18 July	91; 18 July	9 (D)	61; 2 August	4 July–24 October	60
<i>Salvia nemorosa</i>	54; 6 July	53; 20 June	19 (L)	152; 6 June	20 May–4 July; 2 August–24 October	45
<i>Imperata cylindrica</i> ‘Red Baron’	82; 18 July	48; 2 August	–	0	did not flower	45
<i>Miscanthus sinensis</i> ‘Silberspinne’	200; 12 September	210; 12 September	33 (L)	239; 12 September	29 August–7 November	80
<i>Panicum virgatum</i> ‘Shenandoah’	141; 2 August	140; 2 August	29 (L)	160; 2 August	6 July–2 August	70
<i>Sesleria autumnalis</i>	62; 20 June	106; 2 August	9 (L)	120; 29 August	2 August–12 September	70

¹ Observation date on which the maximum mean value was recorded; ² D—diameter; L—length; ³ separate intervals indicate repeated flowering.

Table 3. Functional profile indicators of the evaluated perennial taxa. Darker cell shading denotes more favorable functional performance within each indicator.

Taxon	CCT (Days)	CCP (%)	ACR (%)	OWR (%)	PSR (%)
<i>Echinacea purpurea</i> ‘Golden Skipper’	Not reached	0.0	100.0	67.0	11.0
<i>Hemerocallis</i> ‘Perła Warszawy’	44	83.0	100.1	100.0	100.0
<i>Lythrum salicaria</i> ‘Robin’	53	79.5	105.6	100.0	100.0
<i>Rudbeckia fulgida</i> ‘Goldsturm’	43	83.4	100.0	100.0	100.0
<i>Salvia nemorosa</i>	66	68.7	100.8	100.0	100.0
<i>Imperata cylindrica</i> ‘Red Baron’	109	41.3	100.0	100.0	100.0
<i>Miscanthus sinensis</i> ‘Silberspinne’	60	76.8	106.1	100.0	100.0
<i>Panicum virgatum</i> ‘Shenandoah’	61	76.4	103.7	100.0	100.0
<i>Sesleria autumnalis</i>	55	78.8	104.2	100.0	100.0

CCT—Canopy Closure Time; CCP—Canopy Closure Persistence; ACR—Annual Clump Retention; OWR—Overwintering Rate; PSR—Plant Stand Retention.

The maximum C_t values recorded for eight of the nine evaluated taxa ranged from 107% to 263% (Figure 5). Except for *S. nemorosa* and *I. cylindrica* ‘Red Baron’, the remaining taxa maintained C_t values above 150% during most of the growing season, indicating substantial canopy overlap between adjacent plants at the spacing used. From a planting design perspective, these results indicate the potential for testing wider planting spacing in future applications. Thus, C_t may provide a useful indicator for assessing the adequacy of planting density and supporting more resource-efficient planting design.

ACR values showed minor differences among taxa. Values indicating increases in spread diameter were recorded mainly for the grass taxa, but also for *Lythrum salicaria* ‘Robin’. Moderate expansion is advantageous because it supports gap closure and the persistence of a taxon within the planting. In mixed perennial plantings, however, expansion must remain balanced. Insufficiently vigorous taxa may gradually decline, whereas overly vigorous taxa can suppress neighbouring plants, alter the intended proportions of the composition and increase the need for corrective maintenance. ACR should therefore be interpreted not as a trait to be maximized, but as an indicator of the balance between insufficient growth and potential dominance. This is particularly important in perennial mixtures, whose long-term stability depends on compatible competitive ability and rates of propagation among the component taxa [10,30].

Both OWR and PSR were 100% for all taxa except *E. purpurea* ‘Golden Skipper’, for which the respective values were 67% and 11%. These values indicate reduced survival of this cultivar during the final winter of the study and low stand retention since planting. The very low stand persistence of *E. purpurea* ‘Golden Skipper’ observed in the present study corresponds with the considerable variation in longevity previously reported among cultivated *Echinacea*. In a two-year trial of 21 *Echinacea* taxa, cumulative mortality ranged from 0 to 100%, while mean mortality reached 35% [31]. In contrast, the remaining taxa showed complete overwintering survival in 2023/2024 and full stand retention since planting. These results indicate stand stability through the third growing season after planting and into spring 2024, despite the variable weather conditions recorded during this period, including the dry year of 2022 and severe winter frosts (Figure 2). The high overwintering survival and stand retention observed for most taxa should be considered a crucial characteristic from the perspective of sustainable urban planting, as persistent plant stands reduce the need for replacement planting and the associated consumption of plant material, labour and other establishment resources. In this context, the ability

of the evaluated taxa to persist under variable weather conditions may contribute to the development of more resource-efficient and resilient urban plantings. However, longer-term monitoring is needed to determine whether this stability persists and to assess the longevity of these taxa under these site conditions. Both *Sesleria autumnalis* and *Lythrum salicaria* ‘Robin’ showed complete overwintering and stand retention in the present study, with OWR and PSR values of 100%. In contrast, a three-year study conducted in roadside rain gardens reported substantial, position-dependent mortality in both taxa reaching a maximum of 88% in *S. autumnalis* and 36% in *L. salicaria* ‘Ziegeunerblut’ in the most adverse planting positions [16]. Although a different *Lythrum* cultivar was evaluated, these contrasting results show that overwintering and long-term stand persistence cannot be inferred from taxon identity alone but must be considered in relation to site type and growing conditions.

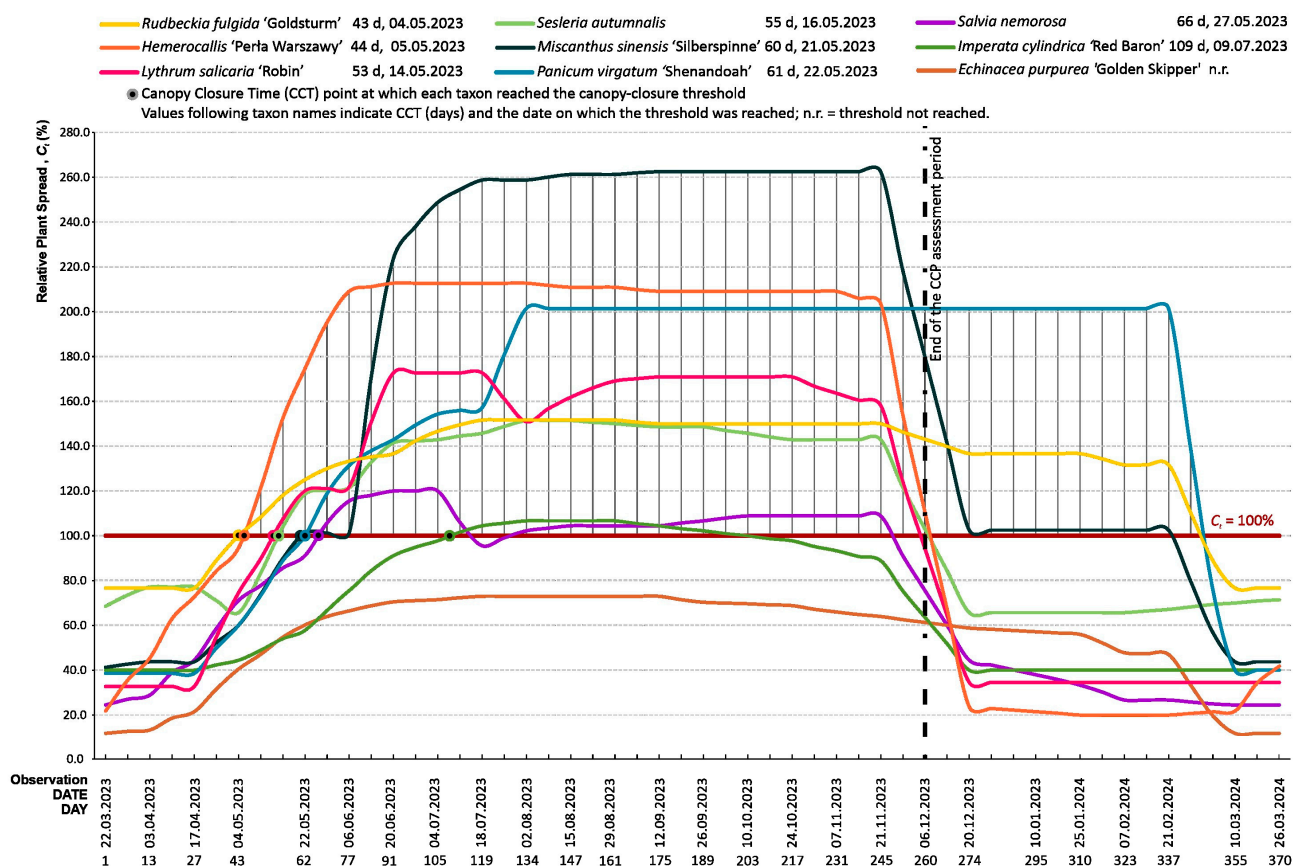


Figure 5. Seasonal dynamics of Relative Plant Spread (C_t) in the nine evaluated taxa over the 370-day observation period. The horizontal line at $C_t = 100\%$ represents the threshold for complete canopy cover. Labels indicate Canopy Closure Time (CCT), expressed as the number of days from the start of the observation period, with the date on which complete cover was first recorded given in parentheses. The vertical dashed line marks the end of the Canopy Cover Persistence (CCP) assessment period.

Ornamental performance varied among taxa reflecting differences in their morphology and course of flowering. Comparison of the individual indicators identified the attributes that contributed most to the seasonal ornamental performance of each taxon (Table 4), while the phenogram showed the timing of the corresponding effects (Figure 6).

The FIE indicator expresses the combined effect of flowering duration and abundance, together with colour impact. The highest FIE values were obtained by *R. fulgida* ‘Goldsturm’ and *M. sinensis* ‘Silberspinne’ (87.5% each), followed by *S. nemorosa* (75.0%), whereas *I. cylindrica* ‘Red Baron’ did not flower during the observation period. The equal FIE values of *R. fulgida* ‘Goldsturm’ and *M. sinensis* ‘Silberspinne’ resulted from different combina-

tions of flowering traits. In *R. fulgida* ‘Goldsturm’, prolonged total and full flowering was combined with numerous flower heads that produced a strong colour impact within the planting. In contrast, *M. sinensis* ‘Silberspinne’ flowered later and for a shorter period but produced a considerably greater number of panicles, which were displayed well above the foliage and collectively created a prominent late-season effect. The warm conditions in September and October (Figure 2) may have prolonged the late-season flowering effects of *R. fulgida* ‘Goldsturm’ and *M. sinensis* ‘Silberspinne’. *S. nemorosa* also produced numerous inflorescences with a very strong colour impact. However, its main flowering period was shorter than those of *R. fulgida* ‘Goldsturm’ and *M. sinensis* ‘Silberspinne’, while the much sparser repeat flowering after cutting contributed only weakly to the subsequent display resulting in a lower FIE. A long-term comparative trial of hardy *Salvia nemorosa* cultivars showed that all evaluated taxa produced some continuous or late-summer rebloom, although flower cover after the primary flush generally remained below 10% [32]. The lower FIE values recorded for *L. salicaria* ‘Robin’, *Hemerocallis* ‘Perła Warszawy’ and *E. purpurea* ‘Golden Skipper’ generally reflected shorter periods of full flowering, lower flower or inflorescence abundance, or both. Thus, even where colour impact was strong it did not fully compensate for the weaker temporal and abundance components.

Table 4. Ornamental performance indicators of the evaluated perennial taxa. Cell colour intensity increases with the indicator value.

Taxon	FIE (%)	FoE (%)	WIE (%)	SV (%)	OC (%)
<i>Echinacea purpurea</i> ‘Golden Skipper’	50.0	67.0	28.6	62.5	91.9
<i>Hemerocallis</i> ‘Perła Warszawy’	43.8	70.3	4.1	62.5	74.3
<i>Lythrum salicaria</i> ‘Robin’	56.3	43.0	0.0	50.0	43.0
<i>Rudbeckia fulgida</i> ‘Goldsturm’	87.5	93.0	28.6	75.0	93.0
<i>Salvia nemorosa</i>	75.0	62.7	0.0	31.3	62.7
<i>Imperata cylindrica</i> ‘Red Baron’	0.0	54.3	0.0	37.5	54.3
<i>Miscanthus sinensis</i> ‘Silberspinne’	87.5	58.9	24.9	100.0	83.8
<i>Panicum virgatum</i> ‘Shenandoah’	50.0	50.5	28.6	87.5	79.2
<i>Sesleria autumnalis</i>	43.8	78.6	0.0	37.5	78.6

FIE—Flowering Effect; FoE—Foliage Effect; WIE—Winter Interest Effect; SV—Structural Value; OC—Ornamental Continuity.

The phenogram (Figure 6) showed that flowering displays of studied taxa extended from early summer into autumn but were unevenly distributed across the season. Most taxa flowered primarily in summer, while *R. fulgida* ‘Goldsturm’ remained in flower until late October, and *M. sinensis* ‘Silberspinne’ and *P. virgatum* ‘Shenandoah’ also contributed to the late-season flowering display. However, no flowering effect was recorded in spring, indicating a seasonal gap in the selection of taxa. Introducing early-flowering perennials, particularly spring geophytes, could fill this gap, extend the flowering season and enhance the visual experience of this public space [10,30]. This is especially important in public plantings, where vegetation can contribute to positive perceptions of a place. In urban perennial mixtures, taxa flowering outside the main summer peak may therefore be particularly valuable. Such temporal distribution also has ecological relevance. Hunter [33] emphasized that maintaining floral resources throughout the pollinator season requires overlapping flowering periods of several species rather than reliance on a single taxon at any given time.

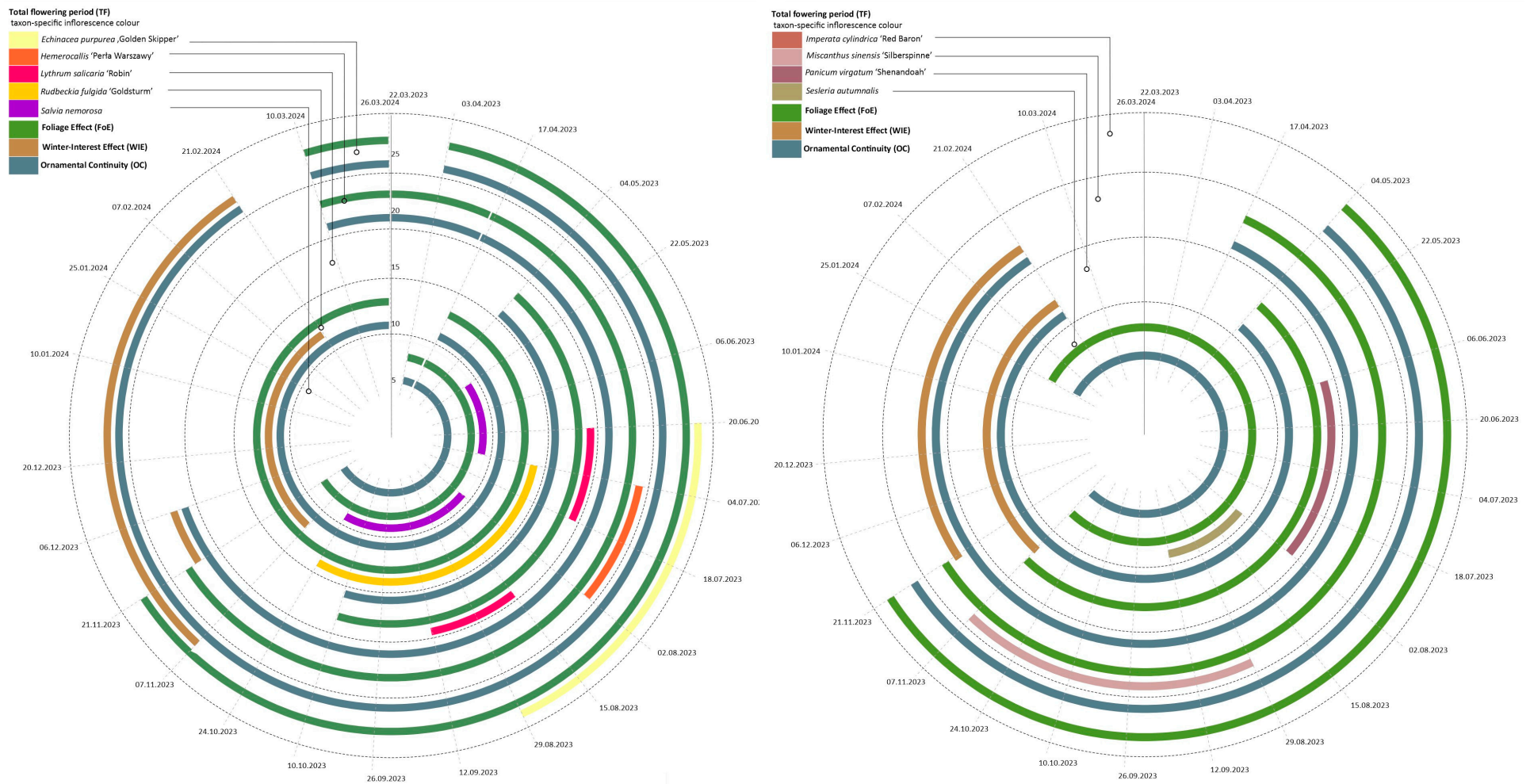


Figure 6. Phenogram showing the seasonal occurrence of the total flowering period (TF), Foliage Effect (FoE), Winter-interest Effect (WIE), and Ornamental Continuity (OC) of the evaluated perennial taxa from 22 March 2023 to 26 March 2024 with maintenance cutting taken into account. Flowering periods are shown in taxon-specific inflorescence colours.

FoE ranged from 43.0% in *L. salicaria* ‘Robin’ to 93.0% in *R. fulgida* ‘Goldsturm’, with a relatively high value also recorded for *S. autumnalis* (78.6%). The lower values of the warm-season grasses, particularly *P. virgatum* ‘Shenandoah’ and *I. cylindrica* ‘Red Baron’, were partly associated with their later spring development, which shortened the period during which their foliage contributed to the composition. In contrast, the relatively high FoE of *S. autumnalis* resulted from its early leaf development in spring and renewed growth after the plants had been cut back in November following the loss of ornamental quality.

Winter interest was greatest in *E. purpurea* ‘Golden Skipper’, *R. fulgida* ‘Goldsturm’, *M. sinensis* ‘Silberspinne’ and *P. virgatum* ‘Shenandoah’, with WIE values ranging from 24.9% to 28.6%. These taxa retained ornamental dry flowering stems, seed heads or standing grass culms after the remaining above-ground parts had senesced. By comparison, the other taxa showed little or no distinct winter interest. WIE was therefore associated largely with the persistence and structural stability of senescent plant parts, which must be retained rather than removed after flowering if their winter ornamental effect is to be preserved.

SV was highest in *M. sinensis* ‘Silberspinne’ (100.0%) and *P. virgatum* ‘Shenandoah’ (87.5%), followed by *R. fulgida* ‘Goldsturm’ (75.0%). The tall, clump-forming habit and persistent upright culms of the grasses allowed them to retain a distinct silhouette across successive seasonal stages. This agrees with the use of large ornamental grasses, including *Miscanthus*, as structural or framework plants in perennial planting design [4,30]. The favourable ornamental performance of *P. virgatum* ‘Shenandoah’ recorded in the present study is consistent with the results of a three-year multilocation trial conducted in the United States, in which the cultivar received high mean ratings for plant form and landscape impact [34]. In contrast, the low SV of *S. nemorosa* (31.3%) reflected the more limited persistence of its form after flowering. Such compact or seasonally expressive taxa may fulfil companion rather than structural roles within a planting.

Differences in the duration of ornamental features were reflected in the OC values, which measure the continuity of ornamental performance throughout the year-long observation period. OC expresses the duration of any recorded ornamental feature; thus, similar values may result from different combinations of ornamental attributes. Overall, OC indicates which taxa contribute to the ornamental display for the longest period and may thus be considered particularly valuable for maintaining its continuity. The highest OC values were recorded for *R. fulgida* ‘Goldsturm’ (93.0%) and *E. purpurea* ‘Golden Skipper’ (91.9%), followed by *M. sinensis* ‘Silberspinne’ (83.8%) and *P. virgatum* ‘Shenandoah’ (79.2%). In *E. purpurea* ‘Golden Skipper’ and the two tall grasses, persistent winter structures extended ornamental continuity after the foliage effect had declined. In *R. fulgida* ‘Goldsturm’, winter interest largely overlapped with the prolonged foliage effect, whereas the relatively high OC of *S. autumnalis* (78.6%) resulted entirely from foliage persistence. The high ornamental continuity of *R. fulgida* ‘Goldsturm’ observed in the present study is consistent with previous evaluations. In a four-year trial the cultivar flowered from mid-July to October, achieved 100% flower coverage and was distinguished by its compact habit and bold-textured basal foliage [35]. Its high overall visual quality, assessed on the basis of plant size, foliage colour and density, and flowering performance, was also reported by Chen et al. [36], confirming that its ornamental value extends beyond the flowering period. The particularly low OC of *L. salicaria* ‘Robin’ reflected the relatively short duration of both its flowering and foliage effects, together with the absence of persistent winter structures. Importantly, high OC values did not necessarily reflect prolonged flowering, but could result from different combinations of flowering, foliage, and persistent winter structures. This highlights the potential of OC to capture the temporal continuity of ornamental performance beyond flowering duration alone. From the perspective of sustainable urban planting, the ability of individual taxa to maintain ornamental interest

over an extended period may be an important consideration when designing long-lasting plant compositions. Combining taxa with complementary periods and types of ornamental interest may help maintain the overall attractiveness of a planting throughout the year. OC therefore provides a simple quantitative measure for comparing the temporal continuity of ornamental performance among taxa and may support the selection of plant combinations designed to maintain long-term ornamental value.

3.3. Cluster Analysis

Hierarchical cluster analysis distinguished four clusters among the evaluated taxa, as shown in the dendrogram (Figure 7A). The accompanying heatmap presents the functional and ornamental indicator profiles underlying this grouping (Figure 7B).

The first cluster comprised four taxa: *S. autumnalis*, *Hemerocallis* ‘Perła Warszawy’, *S. nemorosa*, and *L. salicaria* ‘Robin’. They shared generally favourable functional profiles characterized by relatively rapid canopy closure, high canopy coverage persistence, complete overwintering and high stand persistence. Their ornamental performance was based mainly on foliage persistence in *S. autumnalis* and *Hemerocallis* ‘Perła Warszawy’ and on flowering in *S. nemorosa* and *L. salicaria* ‘Robin’, whereas structural value was generally low to moderate and winter interest was limited. The closest similarity within this cluster was found between *S. autumnalis* and *Hemerocallis* ‘Perła Warszawy’, both of which achieved relatively high OC values mainly through foliage effects. *S. nemorosa* and *L. salicaria* ‘Robin’ formed the second close pair and were characterized by pronounced but relatively short flowering displays.

Imperata cylindrica ‘Red Baron’ formed a separate cluster. Although it showed complete overwintering and high stand persistence, it was distinguished by slow canopy closure, limited canopy coverage persistence, the absence of flowering and low ornamental continuity. Its contribution to the planting was therefore based mainly on seasonal foliage colour.

The third cluster comprised *M. sinensis* ‘Silberspinne’, *P. virgatum* ‘Shenandoah’ and *R. fulgida* ‘Goldsturm’. These taxa combined favourable functional performance with high ornamental value. The two tall ornamental grasses formed the closest pair, sharing high structural value, pronounced winter interest and long ornamental continuity. *R. fulgida* ‘Goldsturm’ achieved a broadly similar overall profile through a different combination of traits, primarily a pronounced flowering effect, long-lasting foliage and persistent post-flowering structures.

E. purpurea ‘Golden Skipper’ formed the fourth cluster on its own. Its distinct position reflected a pronounced contrast between functional and ornamental performance. Despite its relatively high ornamental continuity and winter interest, it did not achieve canopy closure and showed reduced overwintering and very low long-term stand persistence. Thus, its ornamental value was not matched by a comparable contribution to planting stability or spatial continuity.

On the basis of these performance profiles, the evaluated taxa may be assigned to complementary roles in mixed perennial plantings, in which spatial continuity, seasonal display and persistent structure are provided by different plant groups [4,10,30]. *S. autumnalis* may function as a low base layer, whereas *Hemerocallis* ‘Perła Warszawy’, *S. nemorosa* and *L. salicaria* ‘Robin’ may serve as recurring flowering companions. *M. sinensis* ‘Silberspinne’ and *P. virgatum* ‘Shenandoah’ may provide a persistent structural framework, whereas *R. fulgida* ‘Goldsturm’ may form extensive late-season flowering masses and serve as a secondary structural element, particularly in compositions dominated by lower-growing taxa. *I. cylindrica* ‘Red Baron’ appears better suited as a foliage accent than as a matrix-forming taxon. The evaluated *Echinacea* cultivar may be used as a seasonal accent within a persistent matrix, but its low stand persistence suggests that replacement may be necessary. These

assignments reflect performance under the specific conditions of the study and should not be interpreted as universal classifications of these taxa.

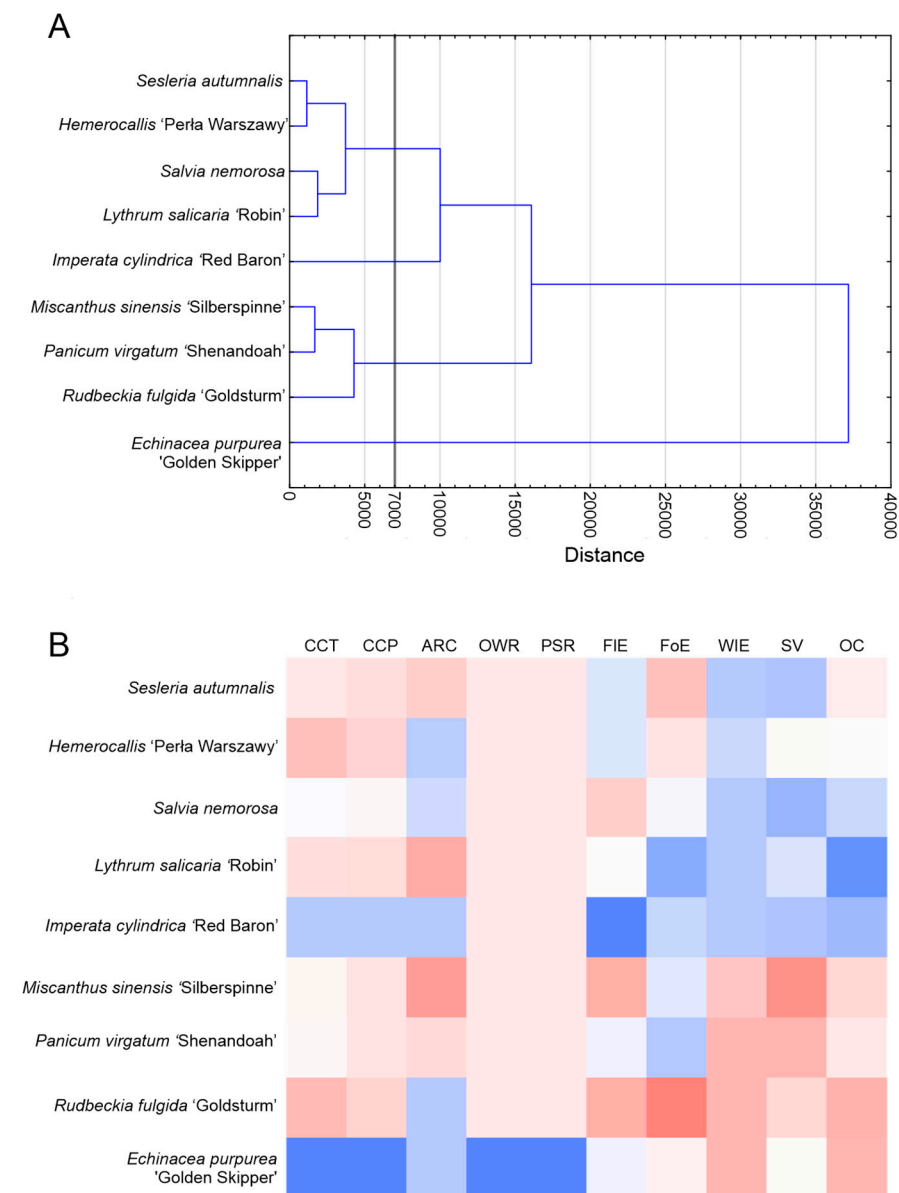


Figure 7. Exploratory hierarchical cluster analysis and heat map of functional and ornamental performance indicators for the evaluated perennial taxa. **(A)** Dendrogram obtained from the original indicator values using Ward's method and squared Euclidean distance. The grey line indicates the cut-off at a linkage distance of 7000 resulting in four clusters. **(B)** Heat map of standardized indicator values with blue and red colours indicating values below and above the mean, respectively. Taxa in the heat map are arranged according to the dendrogram. The heat map does not represent correlations among variables.

4. Conclusions

Sustainable management of public green spaces requires perennial plantings that maintain functional and ornamental value over time while limiting resource use and maintenance inputs. The present study demonstrates that the performance of perennial taxa in public plantings is multidimensional. The results showed the high structural value of *Panicum* and *Miscanthus*, the strong flowering effect and high ornamental continuity of *Rudbeckia*, and the complementary seasonal roles of *Salvia* and *Hemerocallis*, expressed through flowering and persistent canopy cover, respectively. *Imperata* was characterised by

relatively slow canopy closure and low closure persistence, whereas *Echinacea* showed poor overwintering and very low long-term stand retention. *Sesleria* and *Lythrum* combined rapid canopy closure with complete overwintering and stand retention under the conditions of the studied planting. These differences highlight the value of considering multiple aspects of plant performance when selecting taxa for urban perennial compositions.

The proposed indicators provide a complementary framework for assessing canopy development, stand persistence and continuity of ornamental interest. This separation into functional and ornamental profiles enables the identification of trade-offs among taxa, as rapid canopy closure and long-term persistence do not necessarily coincide with prolonged ornamental value, while taxa providing conspicuous flowering may contribute less to ground coverage or stand persistence. The results also show that taxa can fulfil complementary roles within perennial plantings. From a practical perspective, these profiles can support the selection and combination of taxa according to their complementary roles, for example, by combining plants that provide ground coverage and persistence with those that contribute flowering displays and seasonal ornamental interest. This approach may inform the design of resilient and visually attractive urban perennial plantings while helping designers consider maintenance requirements. However, further studies across different urban planting types and growing conditions are needed to assess the broader applicability of the proposed framework.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/su182010527/s1>, File S1: Chronological photographic documentation of the evaluated perennial taxa. The Excel workbook contains one worksheet per taxon with photographic plates comprising images taken at approximately two-week intervals from 22 March 2023 to 26 March 2024 and documenting seasonal changes in plant development, flowering, foliage condition, structural appearance and winter interest.

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Appendix A. Detailed Scoring Criteria for the Components of the Flowering Effect (FIE) and Structural Value (SV) Indicators, Together with the Procedure Used to Calculate Color Impact (CI)

Colour impact (CI) was visually assessed at the stage of maximum flowering based on the impact of flower or inflorescence colour on the overall appearance of the plant. The assessment considered colour visibility, contrast with the foliage and visual dominance. The scores represented the following: 0—no visible colour effect; 1—a very weak, barely

noticeable effect; 2— a moderate, clearly visible but secondary effect; 3—a strong, conspicuous effect; 4—a very strong effect in which flower or inflorescence colour constituted the dominant visual feature of the plant.

Table A1. Scoring criteria for the components of the Flowering Effect (FIE).

FIE Component ¹	Score (Points)				
	0	1	2	3	4
N (no.)	0	1–50	51–100	101–200	>200
CI	absent	very weak	moderate	strong	very strong
TF (days)	absent	1–30	31–60	61–90	>90
	absent	1–15	16–30	31–45	>45

¹ N—the maximum number of simultaneously open flowers or fresh inflorescences per plant; (CI)—colour impact; (TF)—total flowering period.

Table A2. Scoring criteria for the components of Structural Value (SV).

SV Component ¹	Scoring Criteria
SP	0 = no spatial contribution; 1 = weak or subordinate presence; 2 = clearly perceptible but secondary presence; 3 = prominent organizing element; 4 = dominant element defining the planting silhouette.
AR	0 = absent or disordered form; 1 = weakly defined form; 2 = recognizable but not distinctive form; 3 = clear and characteristic architecture; 4 = exceptionally distinctive architecture.
IR	0 = no coherent structural form; 1 = unstable form with severe lodging or collapse; 2 = moderately stable form with evident lodging or deformation; 3 = stable form with limited lodging or deformation; 4 = consistently stable form resistant to lodging.
SD	0 = no structural effect; 1 = structural effect retained continuously for up to 90 days; 2 = structural effect retained continuously for 91–180 days; 3 = structural effect retained continuously for more than 180 days but not throughout winter; 4 = structural effect retained continuously for more than 180 days and throughout winter until spring cutback or regrowth.

¹ (SP)—relative scale and spatial prominence; (AR)—distinctiveness of growth habit and shoot architecture; (IR)—integrity of structural form and resistance to lodging; (SD)—seasonal duration of the structural effect.

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