

A study of adaptive potential and aesthetic impact of Floribunda and Grandiflora rose cultivars in urban landscape in Suhareka, Kosovo: An investigation of vegetative growth and remontant flowering

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Abstract

The rose species and cultivars are considered one of the most valued ornamental shrubs in urban landscape design due to its aesthetic role, positive impact on biodiversity enhancement, high adaptability to various climatic and environmental conditions. The aim of this study is to evaluate the vegetative growth and flowering stage of selected Floribunda and Grandiflora rose cultivars and to assess their adaptive potential and aesthetic impact within urban environments in Suhareka, Kosovo. Ten rose cultivars – eight Floribunda ('Angel Face', 'Sunsprite', 'Amber Queen', 'Bonica 82', 'English Miss', 'Scentimental', 'Betty Boop' and 'Iceberg') and two Grandiflora ('Queen Elizabeth' and 'Love's Promise') – were analysed under the climatic conditions of Kosovo. The most intensive flowering stage occurred in June, with the 'Queen Elizabeth' cultivar producing an average of 35 flowers per plant, followed by the 'Loves Promise' cultivar with 34 flowers per plant. The lowest number of flowers was recorded in the 'Angel Face' cultivar, with 22 flowers per plant, and in the 'Bonica 82' cultivar, with 23 flowers per plant. The cultivars 'Queen Elizabeth' and 'Sunsprite' demonstrated best performance under climatic and environmental conditions of Kosovo. The Grandiflora group of roses blooms more abundantly, which is proven by the effect of additional hybridizations that have been made between hybrid tea roses and the Floribunda group.

Key words: flowering period, growth characteristics, modern roses, urban environments.

Introduction

The use of roses in urban green spaces is primarily guided by their quality and growth characteristics, including flower colour, stem length and diameter, and the continuity of flowering throughout the summer (Godin et al. 1999). A well-designed land-

scape with rose plants contributes to an extended flowering period (reblooming) throughout the summer, accompanied by the continuous development of flower stalks (Crespel et al. 2014). The diversity of flower forms, prolonged and remontant blooming, as well as the wide range of colours and scent, which vary not only

among cultivars but also during different flowering stages, make roses a key ornamental element in the design of parks, flower gardens, and urban environments (Dinga 1998).

The rose is one of the most popular plants among ornamental species in Kosovo, widely used for decorating gardens, parks and vases, as well as for flowers in bouquets (Balaj et al. 2022). Among the most commonly cultivated rose varieties in public green spaces in Kosovo are the following cultivars: 'Double Delight', 'Cristofor Colombo', 'Vaj Vecend', 'Princesse de Monaco', 'Norita', 'Charles de Gaulle', 'Maria Callas', and 'Eiffel Tower'.

Rose flowers can appear singly on a flower stalk or in clusters of 3–25 flowers. The plant blooms once in summer or repeats flowering throughout the summer-reblooming, which is a key feature of modern roses.

Roses are generally classified into two main categories: ancient (or antique) roses, which include varieties cultivated before 1867, and modern roses, which comprise those developed after that year. Modern roses are the result of crossbreeding among European, Chinese, Tea, and Mediterranean rose species, as well as the natural variability observed among rose types during the 18th and 19th centuries. Particularly valued by humans is their ability to bloom continuously or repeatedly throughout the summer (remontant flowering) and their resistance to adverse environmental conditions (American Rose Society 2014).

Floribunda roses are a type of modern garden roses, known for their exceptional adaptability, extended flowering season, and aesthetic appeal, making them an excellent choice for enhancing the beauty and ecological value of urban green spaces. Their flowers may appear singly

or in clusters, exhibiting a wide range of colours and a strong, fine fragrance.

Grandiflora roses are relatively new hybrids resulting from the crossbreeding of hybrid tea roses and Floribunda roses and belong to the group of modern garden roses, known for their ease of cultivation and extended flowering period, characterized by repeated blooming throughout the summer (Cervelli and Paoli 2003). These roses typically initiate blooming with a single flower, followed by successive blooms that create a visually striking effect in green spaces (Blechert and Debenner 2005). The first cultivar of this group, 'Queen Elizabeth', was a pink rose with a notable fragrance.

Today, Grandiflora and Floribunda roses are commonly found in urban parks in diverse colours, with many retaining the characteristic fragrance inherited from their Hybrid Tea parentage (Van de Pol and Pierik 1995).

According to Zieslin (1992), roses are capable of blooming independently on each stem once it reaches a specific length. Research also shows that plant architecture significantly affects both number of flowers per plant and duration of flowering stage (Shimelis and Shiringani 2010). Numerous studies indicate that the performance of roses in landscape design varies according to the cultivar, environmental conditions, and climatic factors (Nadeem et al. 2011). Furthermore, flower production and quality are influenced by the choice of cultivar, cultivation practices, and the type of rootstock used (Cabrera 2002).

The purpose of this study is to evaluate the vegetative growth and flowering stage of selected Floribunda and Grandiflora rose cultivars and to assess their adaptive potential and aesthetic impact within urban environments in Suhareka, Kosovo.

Materials and Methods

The study was conducted in the urban green space 'City Park', located in Suhareka, Republic of Kosovo, over two growing seasons from May 2023 to October 2024, on area of 2500 m² (Fig. 1).

Kosovo is located in the central part of the Balkans. It lies between 41°50'58" and 43°51'42" of northern geographic latitude and between 20°01'3" and 21°48'02" of longitude.

The average monthly temperature during the growing period was in April (13.1 °C), May (16.3 °C), June (20.7 °C), July (24.1 °C), August (22.3 °C) and in September the average temperature was 17.3 °C. The precipitation amount during the growing period was 26.4 mm in April, 79.0 mm in May, 81.0 mm in June, 71.0 mm in July, 55.2 mm in August and in September the average of precipitation was 21.3 mm (HMIK 2023).

In this study, eight Floribunda rose

cultivars – 'Angel Face', 'Sunsprite', 'Amber Queen', 'Bonica 82', 'English Miss', 'Scentimental', 'Betty Boop', and 'Iceberg' – along with two Grandiflora rose cultivars – 'Queen Elizabeth' and 'Love's Promise' – were analysed under the climatic conditions of Kosovo.

The seedlings were produced using the budding method with T-bud grafts, which was performed in August 2021 on rootstock of *Rosa canina* var. Laxa.

The age of the planted plants at the beginning of the experiment was two years. The plants were planted in green spaces with a spacing of 40 cm between individual plants and 100 cm between rows. The experiment was 'Randomized block' type with four replications and 150 plants for each cultivar.

The plants were planted in sandy soil and irrigated during the growth period by drip irrigation system.

During the spring season, field-grown roses were managed using an integrat-

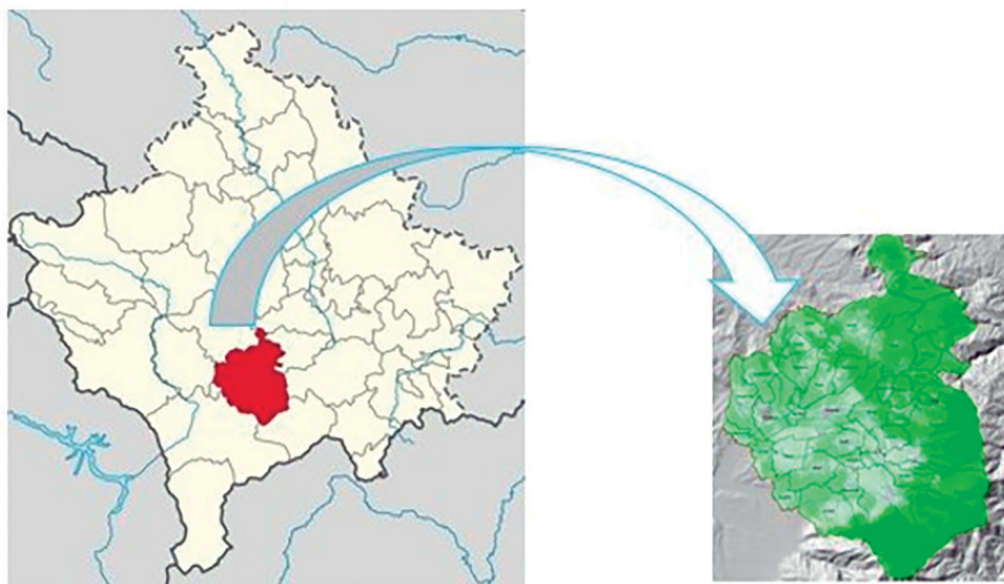


Fig 1. Location of study, Suhareka, Kosovo.

ed fertilization strategy, comprising both organic and mineral fertilizers, applied in accordance with the physiological requirements of the plant at each developmental stage.

In March, well-decomposed organic manure was applied at a rate of 2–3 kg per plant, aiming to improve soil structure, enhance water-holding capacity, and support microbiological activity in the rhizosphere. During the vegetative growth stage (April), ammonium nitrate was applied at a dose of 20–25 g per plant as a source of nitrogen in both ammonium and nitrate forms.

During the flowering stage (May), two key mineral fertilizers were applied: single superphosphate at a dose of 30 g per plant, served as a soluble source of phosphorus to support root development and stimulate flowering.

Potassium sulphate at a dose of 20 g per plant was applied to improve nutrient translocation, enhance the visual and aromatic qualities of flowers, and strengthen plants' resilience against both biotic and abiotic stressors. At the end of June, the spring fertilisation cycle for roses was concluded, having met the plants' nutritional requirements during the key stages of phenological development.

During the growing season, the following parameters were measured: dynamics of the flowering stages, remontant flowering, development stages of rose flowers, diameter of fully opened flowers, number of petals per flower, colour and fragrance, number of flower stalks 50 cm above ground level, diameter of flower stalks, number of leaves per shoots, and density of thorns in 15 cm length per shoot.

For all data, an analysis of variance (ANOVA) was applied using the statistical package, Systat, Genstat, further analysed using rang test with a critical level (P -val-

ue) of 5 % (Gomez and Gomez 1984).

Results and Discussion

Flowering stage of Floribunda and Grandiflora rose cultivars

The results indicate that the flowering stage begins in mid-May, with 1.5 to 2.5 flowers per plant, depending on the cultivar. The most intensive flowering stage occurred in June, with 35 flowers per plant in the 'Queen Elizabeth' cultivar, followed by the 'Loves Promise' cultivar with 34 flowers per plant. The lowest number of flowers was recorded in the 'Angel Face' cultivar with 22 flowers per plant. The other cultivars in the study had the following flower numbers: 'Amber Queen' with 31 flowers per plant, 'Iceberg' with 27 flowers per plant, 'English Miss' with 25 flowers per plant, and 'Betty Boop' with 26 flowers per plant (Fig. 2).

The standard error of the mean ($\pm$ SE) for the number of flowers per plant in the rose cultivars evaluated in this study is as follows: the mean number of flowers per plant was 28.6, with a standard deviation (SD) of 4.74 and a standard error of the mean ($\pm$ SE) of 1.5 flowers. These results indicate that the average number of flowers produced per plant during the growing season (May to October) is associated with a standard error of ± 1.5 flowers.

In July, the highest flower count was observed in the 'Sunsprite' cultivar with 34 flowers per plant, followed by 'Queen Elizabeth' with 25. The lowest number of flowers per plant was recorded in the 'Bonica 82' cultivar with 12, followed by 'Angel Face' with 19, and 'Betty Boop' with 20. During August, the 'Amber Queen' cultivar had the highest flower count, with 20 flowers per plant, followed by 'Sunsprite'

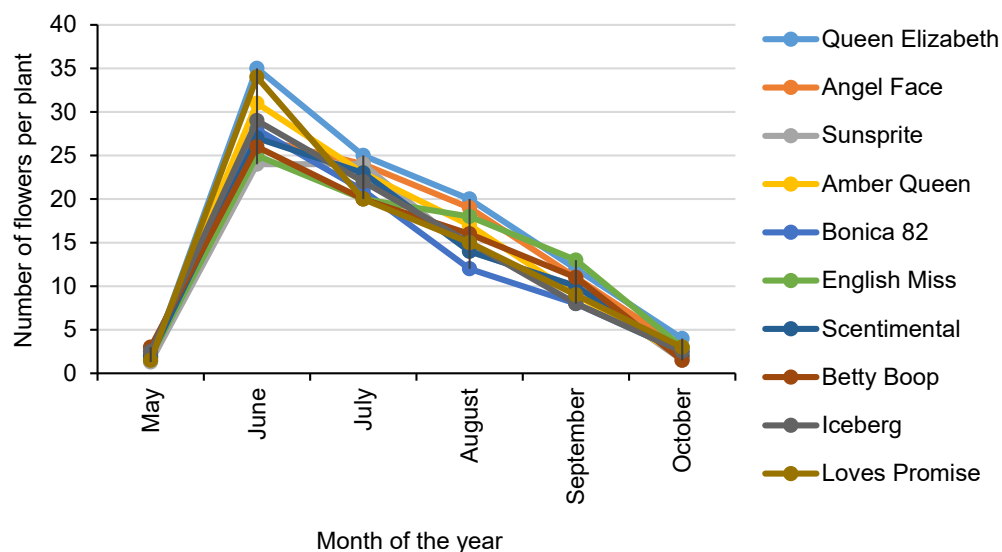


Fig. 2. Flowering stage of Floribunda and Grandiflora rose cultivars.

with 14. The lowest counts were observed in the 'Bonica 82' cultivar with 10 flowers, 'Loves Promise' with 15, and 'Scentimental' with 14 flowers per plant. The lowest number was recorded in the 'Iceberg' cultivar with 8 flowers, while the highest was observed in the 'Scentimental' cultivar with 15 flowers per plant. This decreasing trend continued in October and varied by cultivar. The lowest flower count was found in the 'Betty Boop' cultivar with 1.5 flowers per plant, followed by 'Amber Queen' with 2, and 'Queen Elizabeth' with 4 flowers per plant.

Similar results concerning the number of flowers per plant were reported by Pes-sala (1977), Parkinson (2003), and Crespel et al. (2014). Regarding the flowering stage in Grandiflora rose cultivars, similar findings were reported by Manjula (2005).

Remontant flowering of Floribunda and Grandiflora rose cultivars

The analysis revealed that, during spring, the flowering period is longer, ranging

from 24 to 30 days, depending on the cultivar. In this period, flowers exhibit more vibrant colours and a higher number of blooms per plant. In contrast, during summer, the duration of the flowering succession is shorter between 10 and 16 days and the flower colours tend to be lighter. In autumn, the flowering phase lasts from 19 to 24 days, depending on the cultivar.

These seasonal differences are mainly attributed to variations in temperature, daylight duration, and plant water availability, which significantly influence the physiological processes of flowering (Fig.3).

The results of the study on the repeat flowering of rose cultivars are consistent with the findings of other authors Varies and Dubois (1990), Zieslin (1992), Kool and Van de Pol (1993). Similar results were reported by Dubois and Varies (1993) regarding the flowering stage and the influence of climatic factors in roses cultivars.

The statistical results for the two-year period (2023–2024) are presented in Table

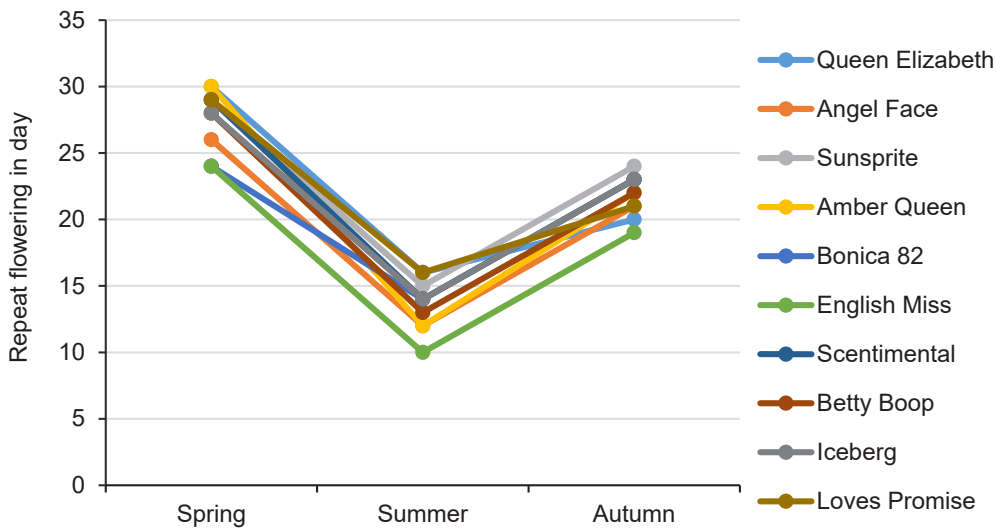


Fig. 3. Remontant flowering in Floribunda and Grandiflora rose cultivars.

1. The analysis of variance indicates that there are statistically significant differences among the Floribunda and Grandiflora rose cultivars in terms of repeat flowering and the diameter of fully opened flowers.

The statistical results for the two years

(2023–2024) are presented in Table 2. The analysis of variance confirms that there are statistically significant differences regarding the flower diameter and the number of flowers per plant of Floribunda and Grandiflora rose cultivars.

Table 1. Analysis of variance for remontant flowering and diameter of fully opened flowers in Floribunda and Grandiflora rose cultivars.

Source of variation	Flowering succession		Diameter of fully opened flower	
	<i>F</i> -value	<i>p</i> -value	<i>F</i> -value	<i>p</i> -value
Year of study	2843.21	0.001	1121.46	0.001
Cultivar	375.67	0.001	1545.24	0.001
Cultivar × Year	12.23	0.001	34.26	0.001

Table 2. Analysis of variance for flower diameter and number of flowers per plant in Floribunda and Grandiflora rose cultivars.

Source of variation	Flower diameter		Number of flowers per plant	
	<i>F</i> -value	<i>p</i> -value	<i>F</i> -value	<i>p</i> -value
Year of study	0.25	0.001	0.31	0.001
Cultivar	208.21	0.001	301.56	0.001
Cultivar × Year	5.21	0.001	4.65	0.001

Developmental stages of flowers in Floribunda and Grandiflora rose cultivars

Seven developmental stages of rose flowers were identified, presented in Figure 4: F1 – unopened bud stage, F2 – semi opened stage, F3 – fully opened stage, F4 – initial bloom stage, F5 – full bloom stage, F6 – bloomed stage, F7 – senescent stage.

These stages are important for evaluating the aesthetic and agronomic performance of the cultivars under urban conditions, as well as for the optimal maintenance planning of green spaces.

Diameter of fully opened flowers of Floribunda and Grandiflora rose cultivars

The maximum diameter of fully opened flowers was recorded in the 'Amber Queen' cultivar, with 12.5 cm, followed by 'Loves Promise' with 11.5 cm. The minimum diameter was recorded in the 'Betty Boop' cultivar, with 5.5 cm (Fig. 5).

The standard error of the mean ($\pm$ SE) for the diameter of fully opened flowers in the rose cultivars included in this study is as follows: the mean flower diameter was 9.4 cm, with a standard deviation (SD) of 1.5 cm and a standard error of the mean

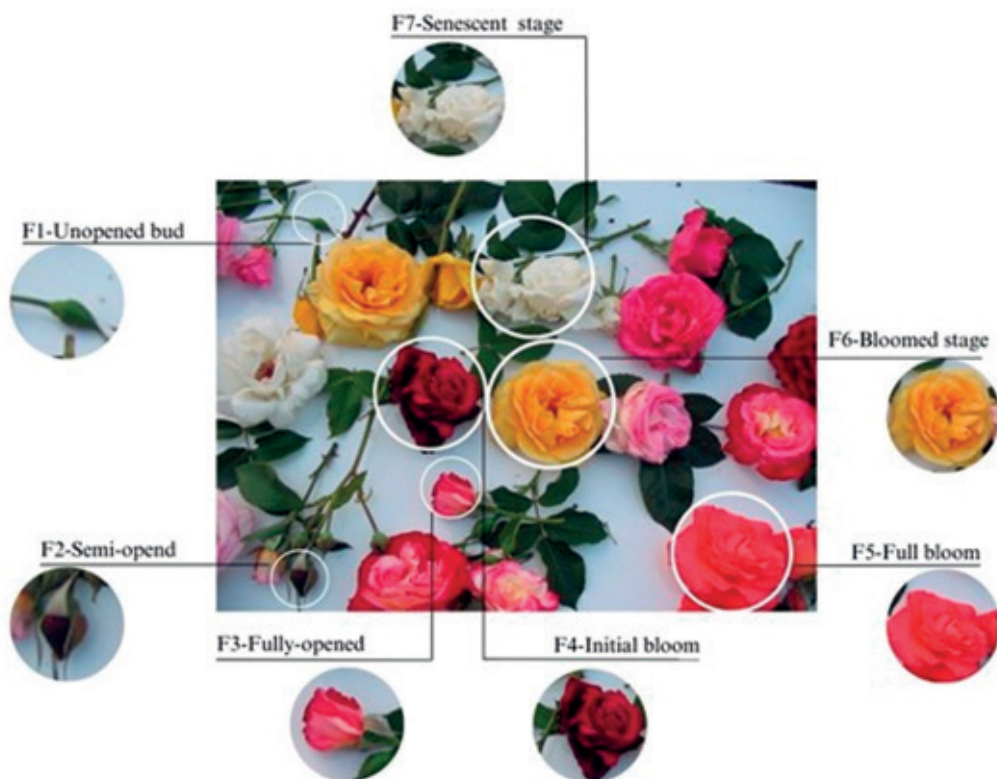
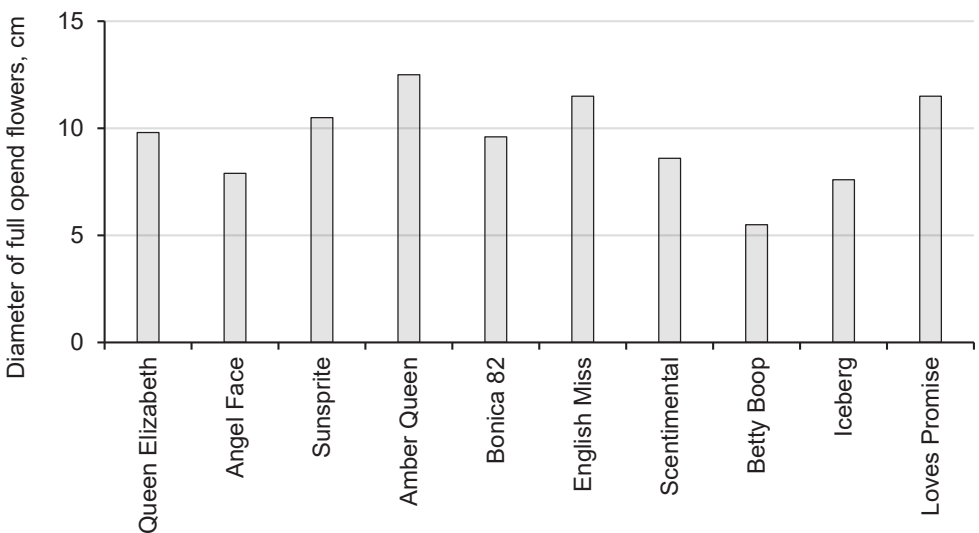


Fig. 4. Seven developmental stages of flowers in Floribunda and Grandiflora rose cultivars.



Floribunda and Grandiflora rose cultivars

Fig. 5. Diameter of fully opened flowers of Floribunda and Grandiflora rose cultivars.

($\pm$ SE) of 0.5 cm. These results indicate that the average diameter of fully opened flowers is associated with a standard error of ± 0.5 cm.

Number of petals per flower, flower colour, and fragrance of Floribunda and Grandiflora rose cultivars

Table 3 presents the number of petals per flower, flower colour, and fragrance

level of the Floribunda and Grandiflora rose cultivars. The highest number of petals was observed in the ‘Bonica 82’ cultivar (35.55), followed by ‘Amber Queen’ (34.35), whereas the lowest number was recorded in ‘Betty Boop’ (10.21). The flower colours among the cultivars ranged from white, yellow, and red to pink and pink-white, contributing to the visual appeal of landscape and park settings. Cultivars exhibiting a strong fragrance included

Table 3. Number of petals per flower, flower colour, and fragrance level in Floribunda and Grandiflora rose cultivars.

Cultivars of <i>Rosa hybrida</i> L.	Number of petals per flower	Flower colour	Fragrance level
Queen Elizabeth	33.15	Clear pink	Light fragrance
Angel Face	30.21	Pink	Very fragrance
Sunsprite	33.23	Yellow	Very fragrance
Amber Queen	34.35	Amber	Mild fragrance
Bonica 82	35.55	Pink	Neutral fragrance
English Miss	30.21	Light pink	Moderate
Scentimental	29.23	Pink	Sweet fragrance
Betty Boop	10.21	Red	Strong fragrance
Iceberg	28.23	White	Little fragrance
Loves Promise	29.23	White	Strong fragrance

'Queen Elizabeth', 'Angel Face', 'Amber Queen', 'Bonica 82', 'English Miss', 'Sentimental', 'Betty Boop', and 'Vaj Vicend'.

Growth in length of flower stalks in Floribunda and Grandiflora rose cultivars

The growth of the flower stalks follows a dynamic pattern, characterized by vigorous elongation during the early stages until the end of June, when the main shoot terminates in a flower. Following the initial bloom, branching begins, with the development of secondary and tertiary shoots, each also ending in flowers. The study confirmed significant differences among the cultivars. The longest flower stalk was recorded in the 'Amber Queen' cultivar (117 cm), followed by 'Queen Elizabeth' (114 cm), while the shortest was observed in the 'English Miss' cultivar (98 cm). Plant height is a cultivar-specific trait and varies between different rose cultivars (Fig. 6).

The results of the study on the growth in length of the flower stalks of rose cultivars are also consistent with studies by other authors (Zieslin and Mor 1990).

The standard error of the mean ($\pm$ SE) for the length of the flower stalks, based on the rose cultivars included in this study, is as follows: the mean flower stalk length was 93.1 cm, with a standard deviation (SD) 8.5 cm and a standard error of the mean ($\pm$ SE) 2.3 cm. These results indicate that the average length of 93.1 cm is associated with a standard error of ± 2.3 cm.

Number of flower stalks per plant, flower stalk diameter, number of leaves per shoot, and thorn density

Table 4 presents the number of flower stalks per plant, stalk diameter, number of leaves per shoot, and thorn density in 15 cm length of shoot for the Floribunda and Grandiflora rose cultivars. The highest number of flower stalks per plant was

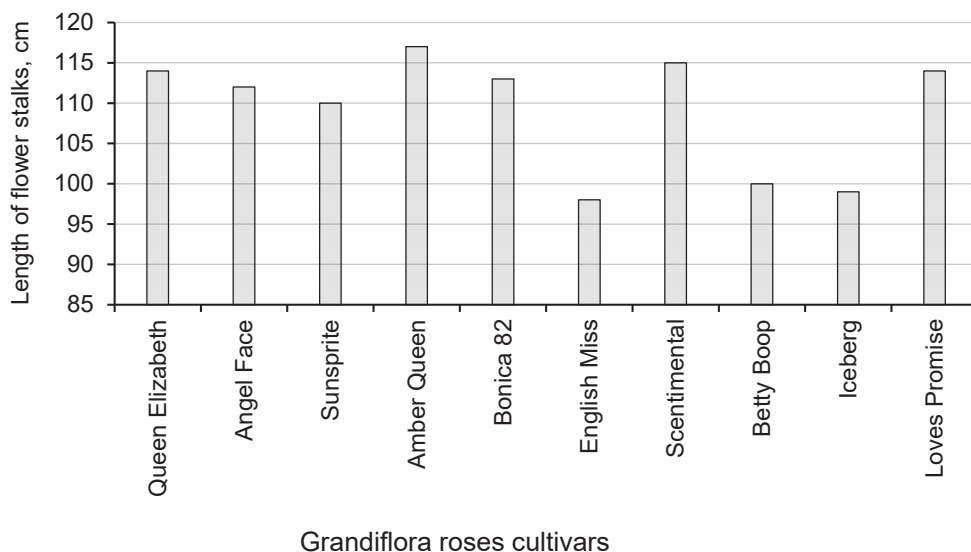


Fig. 6. Growth in length of flower stalks in Floribunda and Grandiflora rose cultivars.

recorded in the ‘Iceberg’ cultivar (8.11), followed by ‘Betty Boop’ (7.88), while the lowest was observed in ‘Scentimental’ (5.11). Regarding stalk diameter, the highest values were recorded in ‘Angel Face’ (9.82 mm), followed by ‘English Miss’ (9.72 mm), whereas the lowest value was observed in ‘Iceberg’ (9.5 mm). The highest number of leaves per shoot was recorded in ‘Queen Elizabeth’ (81.32), followed by ‘English Miss’ (77.45), while ‘Scentimental’ showed the lowest number (55.32). As for thorn density per 15 cm of shoot, the greatest number of thorns was found in ‘Angel Face’ (25.32), followed by

‘Bonica 82’ (23.11), whereas ‘Betty Boop’ recorded the lowest density (13.67).

The statistical results for the two-year period (2023–2024), presented in Table 5, show significant statistical differences regarding the length and diameter of flower stalks of Floribunda and Grandiflora rose cultivars, as confirmed by the analysis of variance. These differences highlight the genetic variability among cultivars in urban environments and landscape projects, where roses that can easily adapt and contribute to the visual beauty and sustainability of green spaces are essential.

Table 4. Average number of flower stalks per plant, flower diameter, number of leaves, and thorn density.

Cultivars of <i>Rosa hybrida</i> L.	Number of flower stalks per plant	Flower stalk diameter, mm	Number of leaves per shoot	Thorn density, per 15 cm of shoots
Queen Elizabeth	6.67	9.45	81.32	24.21
Angel Face	7.33	9.82	66.21	25.32
Sunsprite	6.31	8.81	71.21	20.26
Amber Queen	5.83	8.94	62.32	20.34
Bonica 82	6.54	8.63	68.21	23.11
English Miss	5.56	9.72	77.45	18.23
Scentimental	5.12	7.76	55.32	17.76
Betty Boop	7.88	8.73	70.21	13.67
Iceberg	8.11	9.58	77.29	19.87
Loves Promise	6.56	9.23	75.23	20.34

Table 5. Analysis of variance for flower stalk length and diameter in Floribunda and Grandiflora rose cultivars.

Source of variation	Length of flower stalk		Diameter of flower stalk	
	F-value	p-value	F-value	p-value
Year of study	0.29	0.000	0.42	0.000
Cultivar	221.41	0.000	331.26	0.000
Cultivar x Year	6.44	0.000	4.22	0.000

Conclusions

The long flowering period and significant aesthetic value Floribunda and Grandiflora roses make them ideal for use in urban

green spaces in Kosovo. Their ability to continuously bloom throughout the growing season, accompanied by a wide range of colours, forms, and strong fragrances, makes them perfect for enhancing the vi-

sual and ecological quality of urban environments. Each flower stalk develops and blooms independently once it reaches a certain length, allowing for staggered and continuous flowering. Significant variations were observed among cultivars in relation to succession flowering, fully opened flower diameter, petal count, colour intensity, fragrance, and the number of flower stalks. During spring and autumn, the flowering phase is longer, with brighter colours and a higher number of flowers per plant.

The 'Queen Elizabeth' and 'Sunsprite' cultivars demonstrated the best performance under the climatic and environmental conditions of Kosovo. Given their high ornamental and ecological value, these Floribunda and Grandiflora cultivars are recommended for incorporation into the planning, planting and development of urban green spaces in Kosovo. Their inclusion would not only improve the visual quality of both public and private spaces but also contribute to enriching urban ecosystems, increasing biodiversity, and promoting the overall ecological sustainability of urban environments in Kosovo.

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