

LAVENDER GROWTH AND FLOWERING IN COMPARATIVE PLANTING METHODS

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Abstract

In urban green spaces, flowering plants are frequently grown in raised beds mainly to improve soil conditions and water regime. Along streets and boulevards, raised beds are often planted with resilient flowering plants that require minimal maintenance, such as lavender. Effects of the planting method on growth and flowering were investigated on young lavender plants grown in raised beds and at ground level. The results revealed that plants cultivated in raised beds were smaller in height and diameter at the end of the growing season. Also, flowering duration, size of floral stems and flower production were significantly lower, comparing to those grown at ground level. At the end of the second year of growth, lavender plants cultivated at ground level were double in size and produced a significantly increased amount of flowers. Hot and dry summers should be considered for flowering bedding plants in urban green spaces.

Key words: drought, ground-level planting, *Lavandula angustifolia* 'Sevtopolis', raised beds, urban conditions.

INTRODUCTION

Flowering plants are essential ornamental components with significant visual impact in urban green spaces. Their richness is generally affected by climate (Egerer et al., 2019; Bretzel et al., 2016), soil (Tresch et al., 2018; Wania et al., 2006), pollution (Skaldina et al., 2024; Fahim et al., 2022) and socioeconomic factors (Bernholt et al., 2009; Lowenstein and Minor, 2016; Jogan et al., 2021). In past decades, various researchers have often observed a higher plant species richness in urban areas compared to rural ones, mainly due to non-native species, more adapted to urbanization problems (Loram et al., 2008; Walker et al., 2009; Aronson et al., 2015; Cadotte et al., 2017; Knapp et al., 2017; Potgieter et al., 2024). Rising temperatures and longer drought episodes during growing season, as effects of climate changes, tend to increase the number of non-native species in European cities, especially of those originating from warmer habitats (Schmidt et al., 2014). This is also the case with lavender (*Lavandula angustifolia* Mill.), which in the recent years has become one of the most popular non-native species used in urban green spaces in Bucharest, Romania.

As a flowering plant, with exceptional characteristics such as flower colour, long blooming

period and intense fragrance, *Lavandula* plants are a real attraction for green area visitors. But in Bucharest, lavender is now also present, in green spaces near streets with heavy traffic, attesting its resistance to pollution (Serban et al., 2023). Presence of flowering plants in traffic islands and parking lots has proven that they must be considered for their contribution to urban ecosystem services (Neil & Wu, 2006). However, in urban conditions, the quality of many flowering plants is poor mainly because of soils, especially near different built objectives such as buildings, streets, parking lots etc. and therefore requires improvement of soil conditions (Booze-Daniels et al., 2000; Haselton, 2019). In some cases, it is difficult if not impossible to improve urban soil conditions not only because they are strongly affected, but also built surfaces do not allow easy access to it. For this reason, urban plants are frequently grown in raised beds, using soil, organic amendments or a mixture of substrates (Miernicki et al., 2018). Besides soil conditions, raised beds improve the water regime and weed control, through substrate selection (Cox, 2005; Miernicki et al., 2018) and/or using well adapted plant species, with a high rate of coverage (Matsushima et al., 2017).

Although in the Mediterranean region lavender often grows spontaneously on mountain slopes

at the highest altitudes (Upson & Andrews, 2004), it is perfectly adapted to grow on flat lands, with different soil characteristics. As a flowering plant species, although lavender plants tolerate urban conditions, it is important to identify the factors involved in the flowering process. Flower production is known to be influenced by variety (Mihalascu et al., 2020; Delibaltova et al., 2024), temperature, light (Monaghan et al., 2004), irrigation (Sařata et al., 2020; Akçay et al., 2021) and fertilization (Hassiotis et al., 2014; Minev, 2020; Sarfaraz et al., 2024). Therefore, the aim of present research was to investigate whether the planting method – at ground level or raised beds, has an influence on lavender flowering.

MATERIALS AND METHODS

The comparative experiment was conducted in 2023 and 2024 in Bucharest (44°24'N, 26°05'E), Romania. The city is in the top 10 most-populous cities in the European Union, with a population of 1.7 million residents in an area of 240 km² (NIS, 2025). With a built-up area exceeding 70%, Bucharest is characterized by a temperate continental climate marked by some excessive gradations caused by additional heating and heat radiation of the street network, buildings and pollution. In the region, climate has dry and hot summers (air temperature frequently exceed 35°C) followed by cold winters, with episodes of freezing rain, snowfall and blizzard.

In April 2023, two years old rooted cuttings of *Lavandula angustifolia* 'Sevtopolis', purchased in pots from a local nursery in Sibiu County, were planted using two methods: in raised beds and at ground-level, under field conditions, at the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The experiment was designed to reproduce the soil conditions that flowering plants experience in a real urban plantation. Therefore, the raised beds (of 40 cm height) were permanent, framed with concrete blocks and filled with the existing soil improved with 30% yard waste compost (made at the same institute from leaves, grass clippings, weeds and woody pruning waste collected from campus park and fields), for a lighter texture. The ground level planting plot was delimited and the soil was removed (40

cm deep), improved with the same amount of yard waste compost and then refilled. Both planting type plots had the same size of 1m/5m and were arranged next to each other, in full sun and oriented north-south.

Planting was complete in staggered rows at 30 cm apart.

Irrigation was applied weekly in the first year of cultivation. In the second year, the plants from both planting type plots were not irrigated. For observations and measurements, floral stems were harvested gradually, for the second flowering wave), as they reached full stage of flowering.

No fertilizers were applied during the experiment. No cold protection measures were used during the winter. After the first growing season, all plants were pruned at the same size.

The t-test was used to compare the means of the analysed parameters of two types of planting. The statistical hypotheses were tested with $\alpha \leq 0.05$.

RESULTS AND DISCUSSIONS

Planting method of Lavender 'Sevtopolis' plants had significant impact on their growth.



Figure 1. Plants shape two months after planting

Two months after planting, lavender plants in raised beds were taller compared to those at ground level (Figure 1), which were larger in diameter. By the end of first season, growth

dynamics of the plants had changed and those in the raised beds were significantly smaller in height - 20.1 cm ($p<0.0001$) and diameter - 19.4 cm ($p<0.0001$) than those at ground level - 30.5 cm, respectively, 33.7 cm (Table 1).

Table 1. Growth parameters of *Lavandula angustifolia* 'Sevtopolis' planted in raised beds and at ground level

Planting method	Raised beds	Ground level	P value
First season			
Plant height (cm)	20.1± 0.93	30.5±1.43	*
Plant diameter (cm)	19.4± 0.09	33.7±0.20	*
Second season			
Plant height (cm)	25.8± 0.15	39.6±0.36	*
Plant diameter (cm)	21.4± 0.23	45.2±0.56	*

Data are presented as Mean ± SE.
 NS nonsignificant or * significant differences at $p < 0.05$.

At the end of the first season, the plants grown at ground level have doubled their size compared to those when planting (Figure 2). The plants in the raised beds increased on average their height by 33% and their diameter by 26%.



Figure 2. Plants diameter at the end of first season

In the second season, plants grown at the ground level remain significantly larger than those in raised beds. Lavender plants at ground level remained also larger in size in the second growing season. It was remarked that at ground level plants were twice in diameter compared to those in raised beds. In comparative crops on raised beds versus at ground level, various researchers have shown that growth depends on the species and cultivars. In a field experiment conducted for two

consecutive years, Ram et al. (2004) observed that plants of *Pelargonium graveolens* 'Bourbon' grown at ground level had higher height than those in raised bed (78 cm versus 67 cm, in first year and 111 cm versus 99 cm, in the second year). For 25 cultivars of 11 species of flowering plants such as: *Alternanthera dentata*, *Capsicum annuum*, *Catharanthus roseus*, *Dianthus barbatus*, *Gazania rigens*, *Tagetes patula*, *Petunia hybrida*, *Portulaca grandiflora*, *Salvia splendens*, *Spilantes oleracea* and *Verbena hybrida*, Alsup and Trewatha (2006) found that only 9 of them showed differences in plant height and 12 of them, in plant diameter. In the same research, due to better water and nutrients conditions, 13 cultivars (*Catharanthus roseus* 'Icy Pacifica Pink', *Dianthus barbatus* 'Amazon Neon Cherry', *Petunia hybrida* 'Blue Wave', *Petunia hybrida* 'Clear Waterfall Mix', *Petunia hybrida* 'Easy Wave Pink', *Petunia hybrida* 'Lavender Wave', *Petunia hybrida* 'Madness Magenta', *Petunia hybrida* 'Purple Wave', *Petunia hybrida* 'Stars and Stripes', *Salvia splendens* 'Blue Ribbon', *Tagetes patula* 'Bonanza Harmony', *Tagetes patula* 'Durango Yellow' and *Verbena hybrida* 'Quartz Waterfall Mix') were significantly taller, wider or both, when grown at ground level (Alsup and Trewatha 2006). On the other hand, small shrubs, roses and chrysanthemums are often planted in raised beds for better performance in urban conditions (Chronopoulou & Papafotiou, 2016; Zlesak et al., 2017). The two planting method used in this study did not influenced bud initiation or start of flowering (Table 2).

Table 2. Phenological stages of plants grown in raised beds and at ground level

Planting method	Phenological stages (days)			
	Planting to bud initiation	Bud initiation to flowering	Flowering duration	Last harvest to dormancy
Raised beds	28.8±3.1	18.2±0.4	58.0±1.9	107.4±2.2
Ground level	31.0±2.6	19.1±0.2	81.6±2.7	71.3±2.8
Significance	NS	NS	*	*

Data are presented as Mean ± SE.
 NS nonsignificant or * significant differences at $p < 0.05$

Lavender plants started their flowering at the end of May in both years of observations. The flowering duration of raised beds plants was significantly shorter than of at ground level plants. The average of 23 days' difference between the two planting methods existed

because of the second flowering wave, which occurred only in the plants grown at ground level (Figure 3).

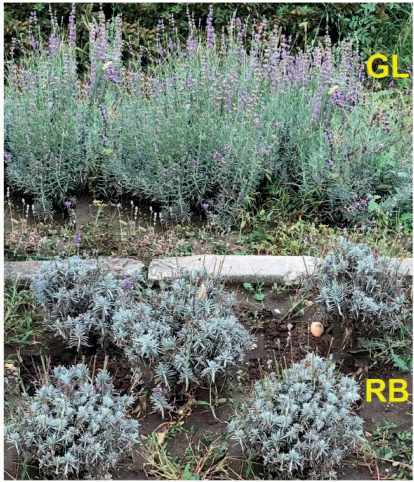


Figure 3. Lavender in raised bed (RB) versus at ground level (GL). Second bloom only at ground level plants

This started in the second half of September and finished at the end of October. Therefore, in both years of observations these plants entered dormancy a month later, in November than those grown in raised beds.

In both experimental seasons, the highest number of floral stems/plant was produced by lavender plants at ground level (Table 3).

Table 3. Flowering parameters of *Lavandula angustifolia* 'Sevtopolis' planted in raised beds and at ground level

Planting method	Number of floral stems/plant	Stems length (cm)	Inflorescence length (cm)
First season			
Raised beds	15.8±0.49	19.4±0.72	7.0±0.34
Ground level	19.4± 0.47	24.8±0.46	9.1±0.44
Significance	*	*	*
Second season			
Raised beds	82.8±0.53	12.5±0.68	6.2±0.42
Ground level	172.2± 0.75	12.9±0.69	6.4±0.63
Significance	*	NS	NS

Data are presented as Mean ± SE.
NS nonsignificant or * significant differences at $p < 0.05$.

Due to their greater volume in the second growing season, ground level plants produced more than double the number of flower stems/plant than those in raised beds. Ground level plants had longer flower stems and inflorescences in the first year of study. In the

following year, plants from both planting methods formed qualitatively similar flower stems, with no significant differences in both stem or inflorescence.

In urban plantations, flowering plants are selected based on their capacity to produce as many flowers as possible in certain conditions. The quantity of flowers produced by these plants is essential to achieve the desired visual impact. Therefore, evaluating flower yield was considered necessary for this research. Flower yield in the first flowering wave was higher in lavender plants grown at ground level (Table 4).

Table 4. Flower yield of plants grown in raised beds and at ground level, in the second year

Planting method	Fresh flower yield (kg.ha ⁻¹)	Dried flower yield (kg.ha ⁻¹)
1 st flowering wave		
Raised beds	1924.8	520.6
Ground level	5142.8	1522.2
2 nd flowering wave		
Raised beds	-	-
Ground level	2334.4	2041.0

Yield of fresh flower was below the potential of 'Sevtopolis' cultivar for both planting methods. Georgieva et al. (2021) who evaluated this cultivar in Bulgaria during 2015-2017, reported a fresh flowers yield of 5800-7000 kg/ha. Lavender 'Sevtopolis' is a Bulgarian cultivar with excellent adaptability, but flower yield may vary in different climate and soil conditions (Stanev, 2010). Our results were obtained in 2024, when the summer temperatures were critical high and combined with drought. Similar results regarding the decrease of flower production in *Lavandula* cultivars under drought conditions have been observed by other researchers (Zhen and Burnett, 2015).

Flowering occurred in two waves - summer and autumn, only in plants grown at ground level. However, these produced fewer flowers in the second flowering wave than in the first. Water loss of flowers after drying was almost similar for the two planting methods, but those harvested from ground level plants had lost less water in the autumn harvest compared to the summer. For six *Lavandula angustifolia* cultivars tested in France, water stress induced a decrease in floral biomass (Saunier et al., 2022). This also happened in our study, although

Lavandula angustifolia is a Mediterranean species adapted to warm and dry climate. In urban green spaces with critical soil conditions, drought-resistant shrubs in their natural habitat may require supplemental irrigation (Schroll et al., 2011). Lavender plants grown in the present study were stressed during summer not only by drought, but also by extremely high temperatures. At roses, Shin et al. (2000) reported a 4 times higher dry weight of flowers at 15°C than at 30°C. The explanation for this difference was that at high temperatures the carbohydrate consumption by respiration increased or the evapotranspiration rate was higher.

After drying, the flowers kept their intense blue colour for more than 6 months, when harvested during summer. Lavender flowers harvested in the fall did not retain their colour after drying and turned almost grey (Figure 4).

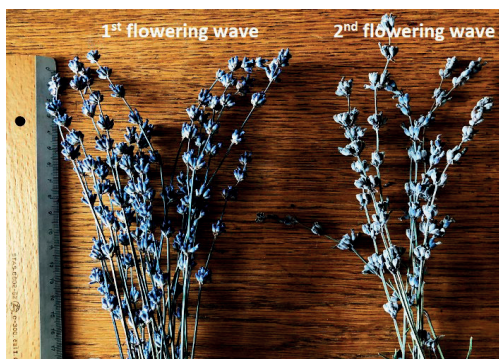


Figure 4. Dried lavender flowers from the 1st and 2nd flowering wave of the ground level plants

Kara et al. (2014) found that drying methods and temperatures have significant influence on the colour of lavandin dry flowers. Minimum level of discoloration occurred at high temperatures, due to a short time of drying process. Our lavender flowers were dried naturally, at room temperature. For this reason, during summer the flowers were dried at a higher temperature than in the autumn and their colour remained more intense.

CONCLUSIONS

In urban areas, raised beds are excellent alternative solutions for poor quality soils. Moreover, raised beds are known to reduce water loss and improve plants water

consumption. Even in the most problematic soils near streets, parking lots or densely built-up zones, raised beds provide growing conditions for a wide variety of flowering plants. Results of the present study revealed that lavender manages harder water stress in raised beds than planted at ground level, under hot and dry summer conditions. Plants growth, flowering duration and flower yield were significantly influenced by planting method, being lower in plants grown in raised beds than at ground level. For this reason, hot and dry summers should be considered for flowering bedding plants in urban green spaces, which may need supplemental irrigation for better performance.

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