Journal of Applied Life Sciences and Environment
https://jurnalalse.com

(Original Article)
https://doi.org/10.46909/alse-551043
Vol. 55, Issue 1 / 2022: 20-30

A COMPARATIVE STUDY OF THE BEHAVIOUR OF *ANTIRRHINUM MAJUS* SPECIES CULTIVATED IN FIELDS AND IN VERTICAL SYSTEMS FOR GREEN FAÇADES UNDER THE CLIMATE CONDITIONS IN THE NORTH-EASTERN REGION OF ROMANIA

Mirela COJOCARIU[a], Elena Liliana CHELARIU[a,*], Ciprian CHIRUŢĂ[b], Petronica AMIŞCULESEI[a] and Andromeda Cristina SONEA[b]

Iasi University of Life Sciences, Faculty of Horticulture, 3, Mihail Sadoveanu Alley, 700490, Iasi, Romania;
[a] Department of Horticultural Technologies, e-mail: mirela_c@uaiasi.ro, amisculesei_petronica@yahoo.com;
[b] Department of Exact Sciences, e-mail: kyru@uaiasi.ro, andromeda.sonea@uaiasi.ro

*Correspondence: julia@uaiasi.ro

Received: Feb. 16, 2022. Revised: July 28, 2022. Accepted: July 29, 2022. Published online: Oct. 07, 2022

ABSTRACT. A highly popular and well-known flowering species for the unmistakable shape of its velvety and beautifully coloured flowers, *Antirrhinum majus* is often used in garden decor due to its long flowering period, ease of cultivation and low maintenance during the growing season. This study aims to investigate the behaviour of a dwarf variety of the *Antirrhinum majus* species grown in both vertical systems for green façades and also in a control field under the climate conditions in the north-eastern region of Romania. The façades of the vertical structure were been oriented towards a cardinal point, each of them having four equal layers arranged on height. The study found that this dwarf variety adapts very well to vertical systems, maintaining its ornamental features for a long time. During the experiment, observations included the diameter, height and number of flowers per plant in the control variant and on each side of the experimental structure.

The highest values in July and August for plant diameter, plant height and the number of flowers were shown for the western facade and the lowest for the control variant. Instead, the control variant in September held the first position showing the highest means for all three monitored parameters and the lowest were for the southern orientation.

Keywords: *Antirrhinum majus*; annual décor; green façades; urban design.

INTRODUCTION

There is no doubt that the flower shape is the specific and unmistakable element of the *Antirrhinum majus* species. These are found grouped on stems in relatively compact racemes, showing a high variety of colours with intense or pastel tones (Toma, 2009). In full sun, the brightness of colour is amplified, making the species extremely attractive for the decor of outdoor spaces.

Originally a perennial plant, the species is most often cultivated as an annual plant (Șelaru, 2007). Varieties differ by plant's strength, overall size, flower size and colour as well as flowering time (Șelaru, 2007).

Although the plant prefers a sunny exposure, its heat needs are moderate (Draghia and Chelariu, 2011). It tolerates semi-shade, although its flowering is low (Toma, 2009). It is cultivated easily in moist, well-drained soils rich in organic matter. It blooms from late spring to late autumn.

The snapdragon dwarf varieties can be used both for the decoration of gardens and parks, arrangement of flatbeds, rounds and flower spots and for the decoration of balconies and terraces or as potted plants and planters (Toma, 2009). Tall cultivars are well-suited for cut flower cultures (Șelaru, 2007).

The compact form of the plant, the healthy green appearance of its leaves, as well as the low maintenance during the vegetation season, turn *A. majus* into an appreciated flower species used in flower compositions that provide the decor of green areas.

These features caught the attention of the research team in studying the behaviour of the *Antirrhinum majus* species grown in vertical systems for green façades to include it into an assortment of ornamental species that could be used in the decor of green façades in the northeast region of Romania.

It has been widely acknowledged that there is no free land for green areas in big cities and urban agglomerates. Urbanisation has generated huge losses of vegetation, which is the main reason for the increase in the urban heat island effect bringing higher energy consumption and air pollution that harms health (Peschardt *et al.*, 2012; Price *et al.*, 2015). Due to limited land availability for parks and other traditional green areas, vegetation was pushed to other surfaces, such as the roofs and façades of buildings (Ghazalli *et al.*, 2019). Their use for extending green areas could be a remedy for habitat ecologisation, as well as for the beautifying of the cities we live in (Francis and Lorimer, 2011).

Green wall systems are sustainable solutions, which, through vegetation reintroduction into urban areas may partially restore the situation before urbanisation and lower its negative effects (Palermo and Turco, 2020). The plants selected for green wall cover are the key factor influencing its efficiency (Sari, 2017).

To make it possible on a large scale, preliminary studies are needed for discovering the decorative plants that would grow adequately and reach their highest potential in vertical systems for green façades under local climate conditions.

MATERIALS AND METHODS

The study material comprises a dwarf variety of the *Antirrhinum majus* species.

The variety, which could reach a height of up to 35 cm at full maturity, has green lanceolate leaves and dark-red flowers. A uniform, branched seedling was used for planting, purchased from local producers of flowering plant material *(Figure 1)*. The plants were placed on the sides of an experimental structure made to study the growing and development method of flower species planted vertically. The sides of the experimental module were oriented toward the cardinal directions *(Figure 2a)*.

Figure 1 - Seedling *Antirrhinum majus*

The experiment was set up in the research field of the Floriculture discipline at the Faculty of Horticulture of the University of Life Sciences Iași, the research being conducted between May 28 and October 05, 2021.

Each surface of the experimental structure *(Figure 2a)* is made of four equal individual tiers arranged in layers. The specimens of *Antirrhinum majus* were arranged in groups of 6, one below the other, on the middle column of each side of the experimental structure. The planting scheme is shown in *Figure 2b*.

The control variant was set up on soil in the same plot of the teaching flower field near the experimental module, and benefits from sun exposure.

The layers of the experimental scheme were watered monthly using 25 litres of water for each side. The control variant was not watered additionally. No fertiliser was used. The average air temperature (°C) and the volume of precipitations (l/sqm) recorded in Iasi during the experiment are shown in *Table 1*. These were extracted from the National Meteorological Administration – Moldova Regional Meteorological Centre.

The features of the seedlings before planting had the following average values: diameter = 12.94 cm, height = 22.82 cm and number of inflorescences = 7.14.

After planting, the observations were made monthly for the following parameters: plant diameter, plant height and the number of inflorescences per plant. Also, photographic monitoring was performed to visually assess the ornamental feature dynamics.

Also, the monthly plant attachment percentage was calculated. This is the percentage calculated out of the total number of plants that had been planted initially on each side of the experimental module and in the control variant, respectively.

For statistical analysis, the values of parameters were compared between the sides of the experimental structure and the control variant on the soil. We analysed height, diameter and the number of pant flowers to establish whether the cardinal orientation influences the evolution of plants in a vertical system. For this purpose, we applied the one way ANOVA statistical test, in which we used around 19 plants per facade and 11 plants for the control variant *(Table 3)*.

To make sure that data have a normal distribution, we applied the Kolmogorov-Smirnov test for normality.

a) b)

Figure 2 - Experimental structure: a) East and South Side (partial) and b) Planting pattern

Table 1 – Average air temperature (^{0}C) and amount of precipitation (l/sqm)

	May	June	July	August	September	October
^{0}C	15.40	20.27	23.27	21.04	14.61	8.98
l/sqm	4.48	5.80	3.59	10.18	1.10	3.60

After testing data for the four facades, we found that they fulfilled the normality condition of the ANOVA test that we had applied using MS Excel from MS Professional Office 2016, with a level of significance of 0.05.

RESULTS AND DISCUSSION

What is specific to the annual flowering species is the fact that they have a fast growth rate and bloom abundantly for several months during the vegetation season (Draghia and Chelariu, 2011).

In the same geo-climatic conditions of Iași city in 2020, the behaviour of several species of ornamental plants was studied which could be used in various systems of covering the facades of buildings (Cojocariu *et al.*, 2022).

This study focuses on the behaviour of the vertically planted snapdragon dwarf variety. In July, the first monitoring month, the best attachment percentage of 83.33% was for the variant on the eastern side, followed closely by the southern and western sides of 79.16%. The lowest attachment percentage of 70.83% was recorded for the northern side.

Once rooted, the subsequent losses were low, so at the end of September, the attachment percentage was over 70% in all locations, except for the north facade, where it was only 66.66%.

The order of variants by attachment percentage (from the highest to the lowest) has remained the same until the end of the monitoring period *Table 2.*

Concerning the plant diameter, after applying the ANOVA test, it was found that in July (p value = 0.383097) and August (p value = 0.415491) the means were relatively close (p value >

0.05). Differences appear for September (p value < 0.0001), with the means not being equal (p value < 0.05).

On average, the plant diameters in July and August were almost equal on all facades of the structure, with differences compared to the control variant in September. The variation of measured values was low in almost all variants over the monitored months (July 1.7 cm, September 6 cm), except for the southern facade, where the variation was high in August (8 cm) *(Figure 3)*. The mean plant diameter value in August was closer to the highest value as there were more plants with higher diameters. In September, the mean plant diameter in the control reached 28.75 cm, the highest value on the experimental module being found on the northern facade (26.60 cm) and the lowest on the southern facade (21.50 cm) *(Figure 3)*.

In all months under observation, the height plant values had statistically different means on each side of the experimental structure according to the one-way ANOVA: July (p-value = 0.018374), August (p-value = 0.04015) and September (p-value = 0.000589). Therefore, cardinal orientation influences the plant height in the studied experimental module.

The mean height on the southern facade had the lowest value of only 15.89 cm, and the highest value on the west façade was 18.89 cm, compared to 20.60 cm in the control *(Figure 4)*.

The number of inflorescences per plant maintained the same pattern as the parameters presented above. In August (p value = 0.1393648) there are no significant differences between the experimental variants (p value > 0.05), but in July (p value = 0.016033) and in September the means were different (p value < 0.05, where p value < 0.0001).

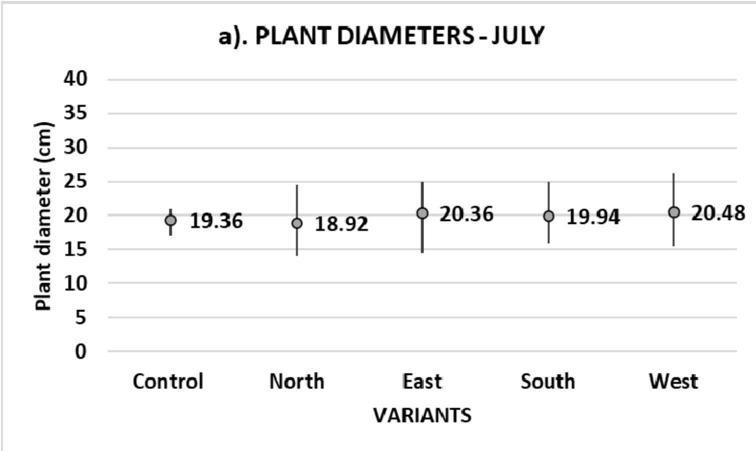
Table 2 - Attachment percentage/survival rate

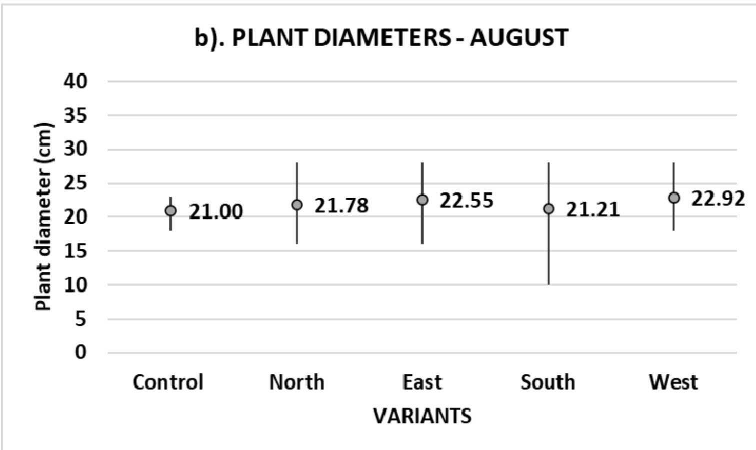
Variants	July	August	September
Control	78.57%	78.57%	71.42%
North	70.83%	66.66%	66.66%
East	83.33%	83.83%	79.16%
South	79.16%	79.16%	75.00%
West	79.16%	75.00%	75.00%

Table 3 - Single-factor ANOVA for plant diameters, July; ANOVA: Single-Factor

Groups	Count	Sum	Average	Variance
Control	11	213.00	19.36	1.90
North	17	321.60	18.92	8.76
East	20	407.20	20.36	7.47
South	19	378.80	19.94	7.16
West	19	389.20	20.48	8.33

ANOVA			
Source of Variation	*SS*	*df*	*MS*
Between Groups	30.2826	4	7.57065
Within Groups	579.9676	81	7.160094





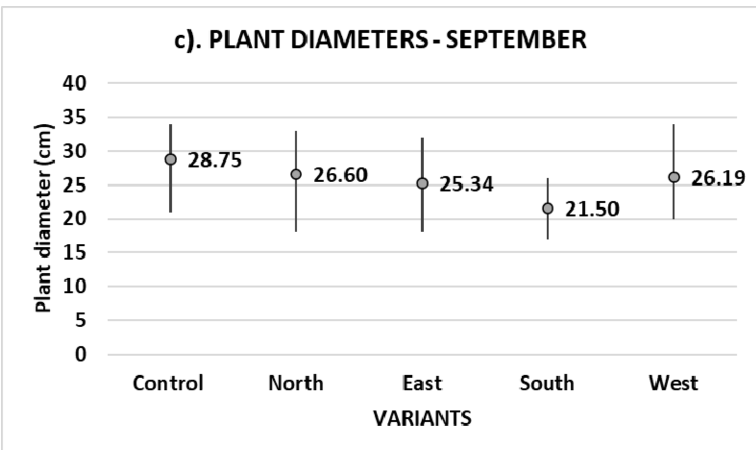


Figure 3 - Mean and Range plant diameters for *Antirrhinum majus* dwarf variety plants in a) July, b) August and c) September

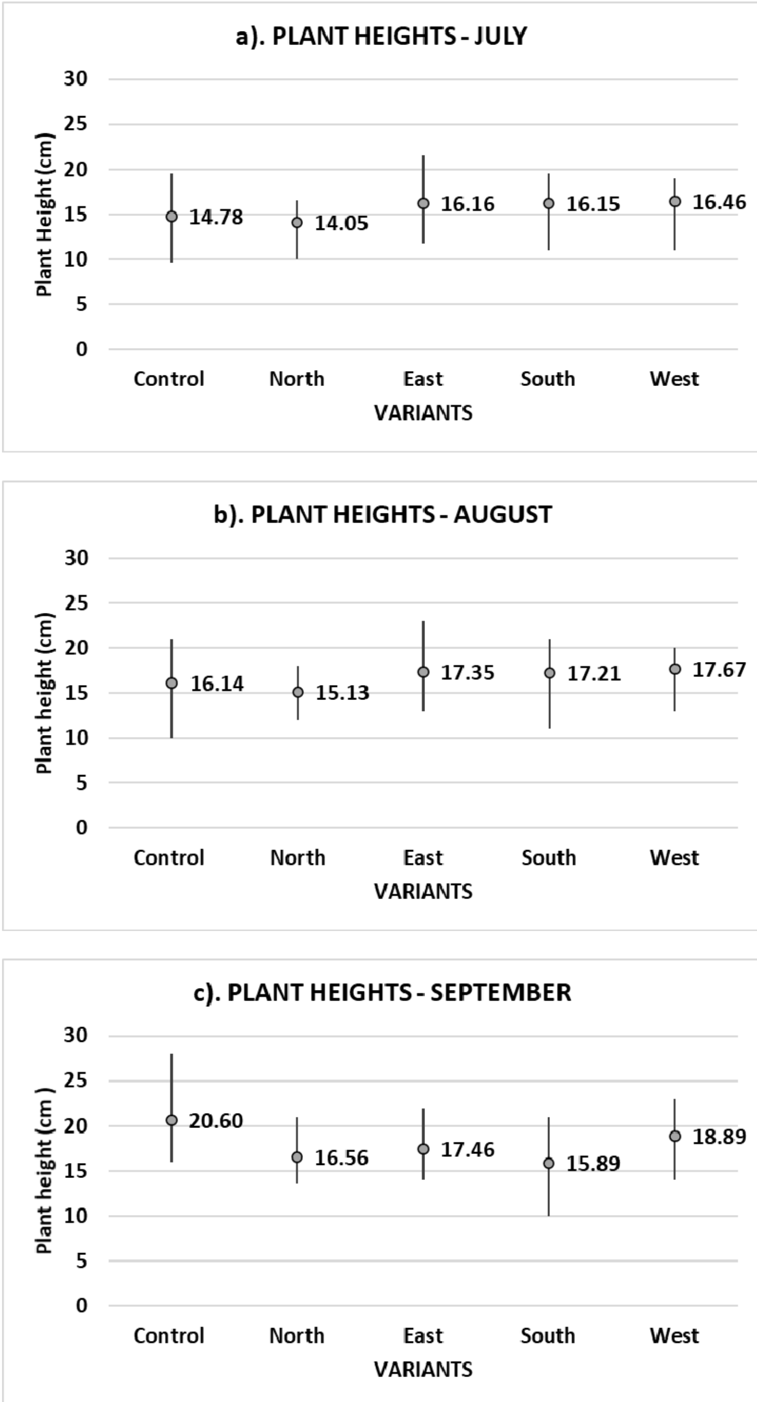


Figure 4 - Mean and Range plant heights for *Antirrhinum majus* dwarf variety plants in a) July, b) August and c) September

For this parameter, the highest differences between mean values on the facades of the experimental structure and the control variant were recorded in September.

If in July, the lowest and highest values in the number of flowers per plant were 10–15, they grew to 16–22 in August and peaked in September, when they ranged between 14 and 43. The highest number of flowers per plant was recorded on the western facade (43) *(Figure 5)*.

Also, the range of values changes over time and shows that although the seedling material was uniform initially, the plants tended to develop differently over time.

So, the highest values in July and August for plant diameter, plant height and the number of flowers were on the western facade and the lowest for the control.

Instead, the control in September held the first position, showing the highest means for all three monitored parameters and the lowest for the southern orientation.

Visual assessment of ornamental features confirmed the evolution of *Antirrhinum majus* plants calculated using statistical analysis of collected data.

Southern placement towards the end of the observation period led to a reduced growth of plants in this orientation.

The control though had an inverse performance. Thus, after a period of slow growth, the plant reached a high decorative potential in September *(Figure 6)*.

CONCLUSION

Antirrhinum majus showed a good growth in all experimental locations. Easy to maintain, it had a high attachment percentage, and the rate of survival was high over the entire period of its behaviour monitoring.

When field planted, it formed a round and compact bush. In the vertical system, the plant acquired a hanging appearance with a tendency to well and quickly cover the vertical surface. The blooming was repeated in each location, although over different periods.

On the experimental structure and the south-oriented facade in September, the specific biometric features had lower values, which indicates, for this month, stagnation in the growth of plants in this orientation.

The maintenance of aesthetic features overall, irrespective of the cardinal orientation, makes the *Antirrhinum majus* dwarf species to be a good proposal for being used not only in the classical system, in soil or pots, but also vertically, in different systems for the decor of green façades.

Our recommendation in this sense considered both the degree of flowering, as well as plant attachment percentage, degree of coverage, resistance to environmental factors and low maintenance, which are highly important features for a green wall species.

For an enhanced decorative effect, it should be planted grouped as a single species and in association with other species.

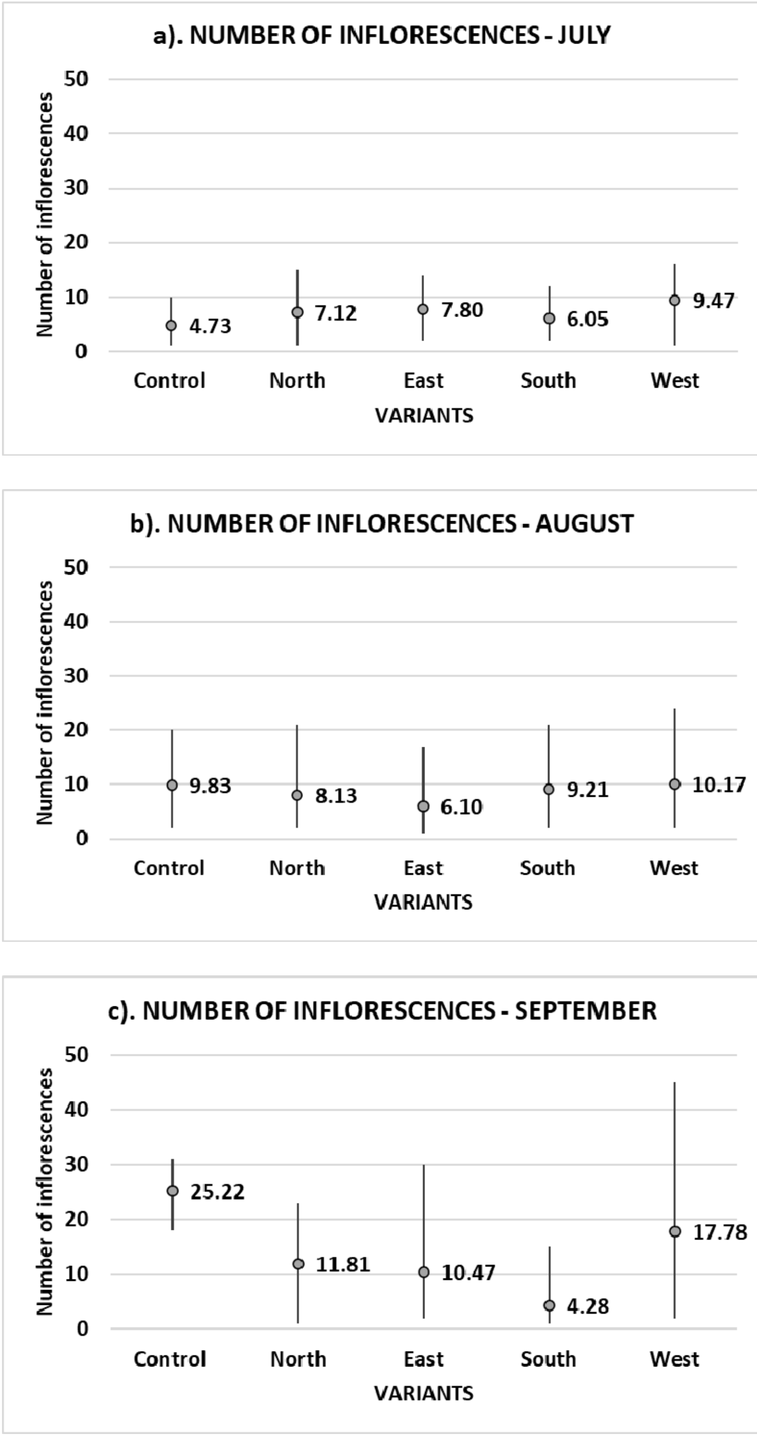


Figure 5 - Mean and Range number of inflorescences for *Antirrhinum majus* dwarf variety plants in a) July, b) August and c) September

North East South West

Control

Figure 6 - *Antirrhinum majus* in experimental variants (September 2021)

Author Contributions: conceptualization (MC, CC), methodology (ELC), analysis (CC), investigation (MC, CC), resources (MC), data curation (AP, ACS), writing (MC, CC), review (MC, CC), supervision (ELC).
All authors declare that they have read and approved the publication of the manuscript in this present form.

Funding: There was no external funding for this study.

Acknowledgments: We thank the National Meteorological Administration – Moldova Regional Meteorological Centre for the climate data.

Conflicts of Interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

REFERENCES

Cojocariu, M.; Chelariu, E.L.; Chiruţă, C. Study on behavior of some perennial flowering species used in vertical systems for green facades in Eastern European climate. *Applied Sciences*. **2022**, 12(1), 474. https://doi.org/10.3390/app12010474.

Draghia, L.; Chelariu, E.L. Floriculture (in Romanian). *"Ion Ionescu de la Brad" Publishing House*. Iasi, Romania, **2011**.

Francis, A.R.; Lorimer, J. Urban reconciliationecology: The potential of living roof sand walls. *Journal of Environmental Management.* **2011**, 92(6), 1429-1437. https://doi.org/10.1016/j.jenvman.2011.01.012.

Ghazalli A.J.; Brack, C.; Bai, X.; Said, I. Physical and non-physical benefits of vertical greenery systems: A review. *Journal of Urban Technology*. **2019**, 26, 53-78. https://doi.org/10.1080/10630732.2019.1637694.

Peschardt, K.K.; Schipperijn, J.; Stigsdotter U.K. Use of small public urban green spaces (SPUGS). *Urban Forestry and Urban Greening*. **2012**, 11(3), 235-244. https://doi.org/10.1016/j.ufug.2012.04.002.

Price, A.; Jones, E.C.; Jefferson, F. Vertical greenery systems as a strategy in urban heat island mitigation. *Water, Air, and Soil Pollution*. **2015**, 226(8). https://doi.org/10.1007/s11270-015-2464-9.

Palermo, S.A.; Turco, M. Green Wall Systems: Where do we stand? *IOP Conference Series Earth and Environmental Science*. **2020**, volume 410, articol no. 012013. https://10.1088/1755-1315/410/1/012.013.

Sari, A.A. Thermal performance of vertical greening system on the building façade: *A Review. AIP Conference Proceedings*. **2017**, volume 1887, article no. 020054. https://10.1063/1.5003537.

Șelaru, E. Garden flower cultivation (in Romanian). *Ceres*. Bucharest, Romania, **2007**, 613-624.

Toma, F. Floriculture and Floral Art, Volume 4, Species Used to Decorate Parks and Gardens (in Romanian). *Ed. Invel Multimedia.* Otopeni, Romania, **2009**, 228-323.

Academic Editor: Dr. Isabela Simion