# THE BEHAVIOUR OF *BEGONIA SEMPERFLORENS* IN VERTICAL SYSTEMS USED FOR GREEN FAÇADES, IN CLIMATIC CONDITIONS SPECIFIC TO THE NORTH-EASTERN PART OF ROMANIA

## COMPORTAREA SPECIEI *BEGONIA SEMPERFLORENS* ÎN SISTEME VERTICALE PENTRU FAȚADE VERZI, ÎN CONDIȚIILE CLIMATICE SPECIFICE ZONEI DE N-E A ROMÂNIEI

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***Abstract.*** *Annual, unpretentious flowering species, Begonia semperflorens 'Big', stands out due to its aesthetic valences constant throughout the growing season. The compact appearance, the abundant and long lasting flowering, the dense and healthy foliage have caused it to be more and more frequently used in the landscaping of parks and urban gardens. This paper aims to study the behavioural pattern of the begonia 'Big' variety in vertical systems for green façades, in the climatic conditions of the N-E part of Europe. The experiment was carried out on height levels, applied to façades oriented towards the four cardinal points with the purpose to conduct a comparative analysis of behaviour, depending on the amount of natural light received specific to each orientation. The study found that Begonia semperflorens 'Big' grown in vertical systems behaves very well regardless of the cardinal orientation of the façade. It is noted, however, that better results were achieved on the north-facing façade in terms of survival rate and coverage.*

**Keywords***: Begonia semperflorens,* green façades, urban design

**Rezumat.** *Specie floricolă anuală, nepretențioasă, Begonia semperflorens 'Big', se remarcă prin valențele sale estetice constante pe tot parcursul sezonului de vegetație. Aspectul compact, înflorirea abundentă şi îndelungată, frunzişul des şi sănătos au condus la utilizarea sa, tot mai frecvent, în decorul parcurilor şi grădinilor urbane. Lucrarea de față își propune studierea comportării soiului begonia 'Big', în sisteme verticale pentru fațade verzi, în condițiile de climă din zona de N-E a Europei. Experiența a fost realizată pe paliere de înălțime, aplicate pe fațade orientate către cele patru puncte cardinale cu scopul de a analiza modul său de comportare comparativ, în funcție de cantitatea de lumină naturală primită specifică fiecărei orientări. În urma studiului s-a constatat faptul că, Begonia semperflorens 'Big' cultivată în sisteme verticale se comportă foarte bine indiferent de orientarea cardinală a fațadei. Se remarcă totuşi faptul că pe fațada orientată spre nord în ceea ce priveşte rata de prindere precum şi gradul de acoperire s-au obşinut rezultate mai bune.*

**Cuvintecheie:** *Begonia semperflorens*, fațadeverzi, design urban

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## INTRODUCTION

Over time, genus *Begonia* has delighted people with its remarkable species through foliage or flowers or through foliage and flowers alike. The common feature of the many species belonging to the genus *Begonia* is its fleshy leaves positioned asymmetrically on the stem whose shape and colouring are very varied (Chelariu, 2015).

*Begonia semperflorens* 'Big' is quite similar to the betterknown basic species although it displays some improved characteristics namely: higher height, larger leaves, more numerous and larger flowers than common basic species. These plants are ideally suitable for use in full sun or open shade in layers or containers (https://www.uaex.edu/yard-garden/resource-library/plant-week/Begonia-x-benariensis-Big-Begonias-09-18-2015.aspx).

The plant prefers partial shade, but it also tolerates considerable shade, although, in this case, the number of flowers will be smaller. It develops best in conditions of constant humidity throughout the growing season, but it tolerates drought periods due to the thick and waxy leaves, which help to minimize water losses during warm weather. They are easily grown in any well-drained, organic-rich soil with moderate fertility (https://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=a562).

In full sun or partial shade, in layers or containers, alone or combined with other annual species, *Begonia semperflorens* 'Big' displays its healthy foliage and flower waves from June to late autumn. Although the flowers are not spectacular, continuous and abundant flowering make begonia a great choice to achieve colour spots on any surface, horizontal or vertical.

The fact that in urban areas it is unlikely to extend green areas horizontally because of lack of space, the idea of using the buildings' façades and tops for this purpose becomes logical and arouses increasing interest. They represent not only a viable solution in the greening of habitats (Francis and Lorimer, 2011) but also aesthetics, thus saving many cities from pollution and aridity (Dascălu and Cojocariu 2016). In this respect, studying the behaviour of various ornamental species in vertical systems for green façades becomes a priority.

## MATERIAL AND METHOD

The study material is represented by the species *Begonia semperflorens* hybrid 'Big'. Vigorous hybrid with erect stems, which can reach a height of up to 50 cm, bearing large pink, pearly flowers, above the green, healthy leaves. For the experiment there was used mature uniform seedling (fig.1). The seedling were planted on the façades oriented to wards the four cardinal points on an experimental structure (fig. 2a) built for the purpose of studying the behavioural pattern of some flower species planted vertically.

**Fig. 1** *Begonia semperflorens*'Big'

The experiment was set upon the teaching field of the Floriculture department within the Faculty of Horticulture of UASVM Iaşi and the research was carried out from its beginning (end of June) until October 2020.

The experimental structure (fig. 2a), in the shape of a square,displays 4 bearings on each side positioned one on top of other, with a small space between them to allow watering. On each façade of the experimental structure there were arranged 24 plants, in groups of 6, one on each of the 4 bearings. Begonia groups were positioned, one below the other, on the same "column" according to the planting scheme shown in figure 2 b.

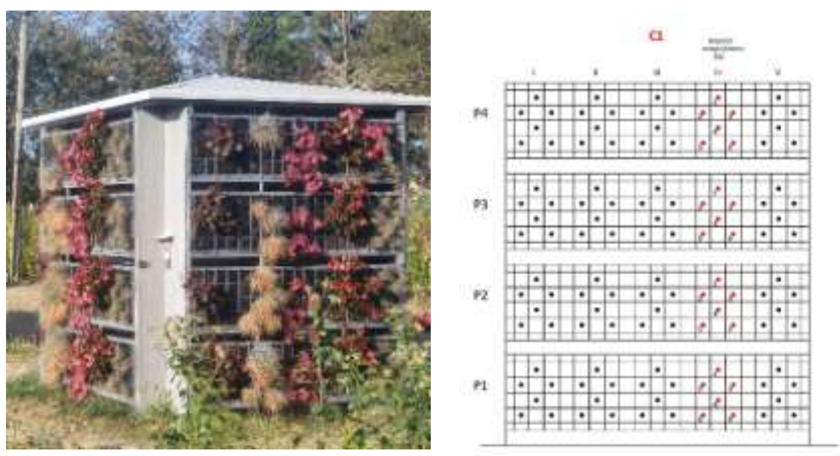
The substrate soil used in the experiment contains a mixture of white peat, bricks and white peat fibres and has a pH value equal to 6.

To stimulate branching, two weeks after planting, each plant was shortened to approx. 10 cm.

Three measurements were realised every month, monitoring, in addition to the survival rate, the following characteristics: plant height, plant diameter, number of leaves and number of inflorescences.

Research methods used: theoretical documentation, experience, systematic observation, analysis and synthesis of the data obtained, statistical interpretation.

Two-way Anova and correlation and regression analysis were used for the statistical interpretation of data.




**a)**Western and Southern Façades **b)**Planting scheme

**Fig. 2**Experimental structure

## RESULTS AND DISCUSSIONS

A 1986 study that monitored the effect of different light intensities on the growth and flowering of *Begonia semperflorens* revealed that plant height, plant width and leaf area are larger as light intensity decreases (Jeong *et al*, 1986).

Throughout our research, we have monitored the behavioural pattern of the *Begonia semperflorens* 'Big' planted in vertical systems facing the four cardinal points with the intensity of light being naturally different from one point to another.

In terms of the survival percentage, the best result, 83.33%, was recorded on the north-facing façade while the lowest percentage, 62.50% was recorded on the western façade. The eastern and southern façades achieved an equal percentage of 66.66%.

Visual evaluation of the ornamental features of the begonia plants on each of the four façadesshowed that on the façade facing north the appearance of the plants is much more compact forming a continuous floral "column" without any gaps, even if the survival percentage was not 100%. On the southern and western façades, where the natural light intensity is naturally higher, it has been observed that the leaves are tighter leading to a generally less compact appearance.

The analysis of collected data showed that, at each measurement, on the northern façade the plants obtained the highest values, both in terms of diameter (fig.3) and height (fig.4), compared to the other façades where the two parameters monitored recorded lower values.


**Fig.3** Plant diameter

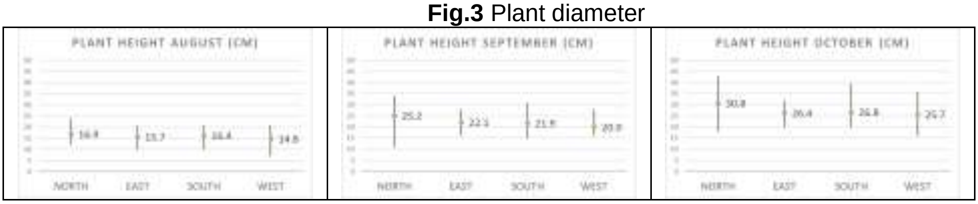



**Fig.4** Plant height

In terms of the average number of inflorescences, the evolution was different on each façade. Thus, if in August the highest average number of inflorescences was obtained on the northern façade and the smallest on the western façade, in October, on the same façades the situation was reversed, in the sense that on the northern façade was recorded the lowest average number and on the western façade, the highest average number at this feature (fig.5).

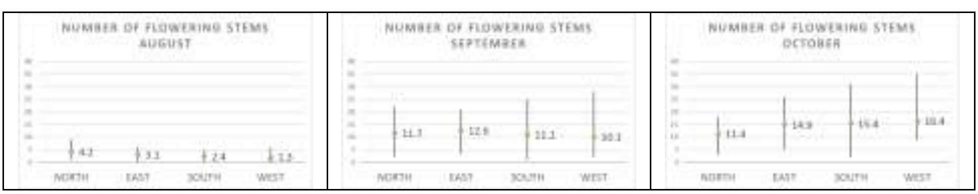



**Fig.5** Number of inflorescences

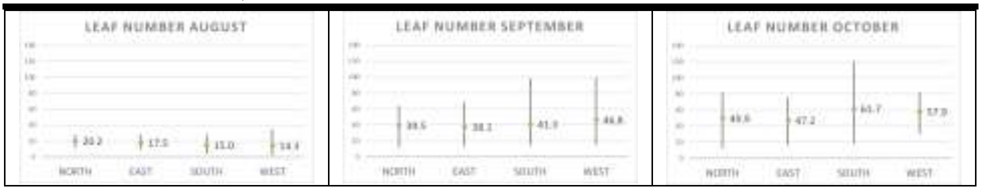



**Fig.6** Number of leaves

The average number of leaves per plant reached its highest value on the western façade in September and on the southern façade in October. On the eastern façade, both in September and October, this parameter recorded the lowest value.

Two-way Anova and correlation and regression analysis were used for the correct analysis of the mean values obtained for the parameters being monitored. The Two-way Anovastatistical test was used to assess the impact/effect the month and the cardinal orientation of the façade might have on each monitored parameter as well as whether there is some interaction between the two factors (the calendar month and the façade orientation).

The Two-way Anova test, for the characteristic expressing the diameter of the plant,determined for *p value* the numbers 1,97E-30, 8.63E-8 <0.05 ($\alpha$= 0.05 significance level) indicating that both the month in which the measurements were made and the cardinal orientation influenced the diameter of the plant.

On the other hand, the interaction effect between these two factors (orientation and calendar month) is not significant because *p value* = 0.748 is greater than the level of significance. The effect that the calendar month produces on the diameter of the plant does not change from one façade to another. This effect was retained on each side of the experimental module (plus or minus any errors). Thus, in October were recorded the highest averages of plants' diameter regardless of the façade of the experimental scheme while the smallest were recorded in August.

The minimum value of the average diameter of plants varies between 16.2 cm August on the western façade to the maximum value 34.5 in October on the north façade.

The same statistical characteristics shall be retained for the parameter defining the height of plants where *p value* obtains the values 7.323E-3, 2.172E-6 < 0.05 and 0.345 respectively for the interaction between the factors.

The minimum average value for plant height is 14.8 cm on the western side in August and the maximum mean value of 30.8 cm in October for the north-facing side.

Regarding the number of floriferous rods, the *p value* is 2.15 E-20 <0.05 for the three months in which the measurements were made, meaning that, for this parameter, the calendar month is the statistically significant factor influencing its values.

On the other hand, the orientation of the façades of the experimental scheme and the interaction between the factors analysed are not significant for the number of floriferous rods because the values of *p value* (0.886 and 0.188 respectively) are greater than the level of significance. The effect that the month in which the monitoring was carried out might have on the number of floriferous rods does not change from one side of the experimental scheme to another. Therefore, the mean value obtained in each of the three calendar months is similar on each façade of the experimental module.

The range of variation for the mean values of number of floriferous rods is between 1.3in August on the west side and 16.4 in October on the west face. The samples for the months in the analysis are different.

Considering the values obtained by the *p value*, for the characteristic expressing the number of leaves per plant (p value = 7.6 E-25< 0.05 and 0.153 and 0.153 respectively 0.276> 0.05) the same conclusions can be drawn as for the parameter presented above, namely that the calendar month influenced the number of leaves per plant while the cardinal orientation did not produce any significant effect on this characteristic. Also, the interaction between the two factors (calendar month and cardinal orientation) is not significant.

At the same time, the analysis of the correlation and regression of the parameters (Chiruta, 2019) between the height of the plant and the diameter of the plant, i.e. the diameter of the plant and the number of flowers, was used for the statistical interpretation of the data collected.

In the case of the first two parameters being analysed, for the northern façade, the correlation coefficient records the values: 0.37 (August), 0.69 (September) and 0.73 (October) while for the southern façade, it records 0.47(August), 0.77(September) and 0.76 (October), indicating an increasingly better correlation between the two parameters from one measurement to another. A very good correlation between these two parameters is also noticeable on the western façade where the correlation coefficient is more than 0.7 in each of the three months.

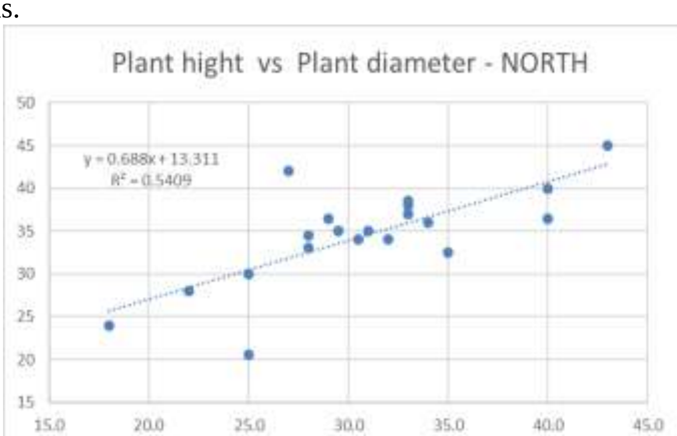



**Fig.7**Regression line –plant height vs. plant diameter

Figure 7 shows the regression right y=0.688x+13.311 and the coefficient $R^2$ = 0.54 indicating that the height of the plant, on the north façade, influences 54% of its diameter.

Correlation and regression analysis of parameters, between the diameter of the plant and the number of flowers, highlights that in the case of the northern and western façades there is a better level of correlation between the two parameters, from one month to the next.

Thus, on the northern façade, a correlation coefficient of 0.35 was obtained in August, 0.80 in September and 0.85 in October. On the western façade, the correlation coefficient recorded the following values: 0.66in August, 0.92in September and 0.80in October.

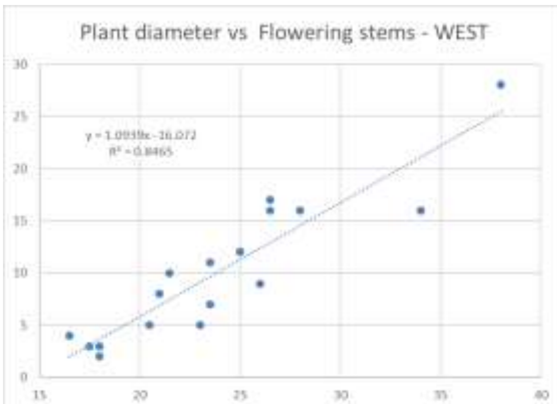



**Fig.8** Regression line –Plant diameter vs. flowering stems

Figure 8 shows the regression line y=1.0939x-16.072. Thus, the diameter of the plant influences in proportion of 84 % (R2 =0.84) the number of inflorescences per plant on the western façade.

## CONCLUSIONS

1. *Begonia semperflorens* 'Big' stands out due to a number of extremely important qualities: compact and lasting appearance, thick healthy foliage, abundant and long lasting flowering. It is also not very pretentious concerning the environmental conditions.

2. Although on the north-facing façade, certain biometric features have recorded better values, it can be said that the plants maintain their aesthetic valences regardless of the cardinal orientation.

3. When vertically grown, the plant is characterised by a good degree of coverage in a relatively short time. Planted on the ground the stems are vertical, giving the plant an erect appearance. In vertical systems, inflorescences overlap in successive wavesgiving the plant a flowing appearance.

4. All these facts recommend *Begonia semperflorens* 'Big' for use not only on the ground but also vertically in various systems for green façades.

5. The mean values recorded by two biometric parameters being monitored in the experiment (number of leaves and number of inflorescences) were influenced by the calendar month in which the measurement was made. On the other hand, the mean values obtained for the height and diameter of the plant were influenced both by the calendar month in which the measurement was made and by the cardinal orientation of the façades of the experimental scheme. The interaction between the two factors (calendar month and cardinal orientation) is not significant for either parameter.

6. On the northern façade the height of the plant influences 54% of the diameter of the plant and this influences the number of inflorescences, on the western façade in proportion of 84%.

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