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# THE INFLUENCE OF SUBSTRATE TYPE ON GROWTH AND FLOWERING OF GERBERA PLANTS

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***Abstract***

*The study was made in greenhouses conditions on three gerbera cultivars, 'Dune', 'Blind Date' and 'Balance'. We analyzed the effect of five type of substrates on growth and flowering of gerbera. The types of substrate used were following: peat is acidic both with pH 4 and with pH 5.5 peat with pH 4, peat with pH 5.5, Perlite, 50% Perlite + 50%, peat with pH 4.0 and 50% Perlite+ 50% peat with pH 5.5. The best results was obtained when we used the substrate 50% Perlite+ 50% peat with* pH 5.5 *regarding number of flowers, flower height, flower diameter, shoot diameter, showed significant difference among growing media.*

***Key words****: Gerbera jamesonii, substrate, fertilizers, condition of growing.*

## INTRODUCTION

Gerbera (*Gerbera jamesonii* Bolus), *Asteraceae* family is a species originally from southern Africa and Asia (Gao and Hind, 2011; Francielly et al., 2016**).** The flower is very elegant, and this impresses through the diversity of forms and colours of the inflorescences. Worldwide, gerbera is considered one of the most ornamental flowers cultivated both as cut flower and potted plant.

The growers used different methods for multiplicated from seeds, transplants and micropropagation (Pablo et al. 2002).

In recent years, the cultivation of gerbera for cut flowers or potted has gained great economic importance for floriculture (Santos et al., 2015; Francielly et al., 2016; Toma et al., 2019**).**

Cultivation on different inert substrates is the most modern method of gerbera culture, with very favorable results in terms of productivity, plant health and production quality. Awang et al. (2009) mentioned that suitable growing substrates are essential for quality flower production as these affect development and maintenance of plant rooting system. Noureen et al. (2010), Ahmad et al. (2012) shows that substrates are used for growing seedlings, plant propagation of gerbera. Different types of substrate are used for growing gerbera as coconut fiber (coco peat), rock wool, perlite, vermiculite, sand, expanded clay or different organic substrates, (compost cow, zeolite, pumice, sand etc. (Khalaj, 2007; Fakhri et al., 1995). Gerbera cultivated in a soilless system is currently practiced with the aim of increasing production and reducing costs (Maloupa et al., 1993).

Jesiotr et al. (1975) recommend with good results the pine bark compost when mixed with other types of substrate such as sphagnum peat.

Peat is the most widely used substrate for potted plant production in the nurseries and accounts for a significant portion of the materials used to grow potted plants (Marfa et al., 2002; Ribeiro et al., 2007). Since the last few years, coco peat, also known as coir dust or coconut mesocarp has been considered as a renewable sphagnum peat substitute for the use in horticulture (Yau and Murphy, 2000).

Perlite is an inert substrate providing excellent drainage of the medium and aeration of rhizosphere (Özçelik, 1997; Enache et al., 2019). Performance of plants of gerbera 'Dafne' cultivar grown in 100% coconut fibre substrate was attributed to their strong capacity to accumulate Fe in the aerial part under alkaline conditions and to maintain a better plant nutritional status, higher P and Mg (Hamid et al., 2016; Aung et al., 2017). The

researchers concluded that the use of coconut fibre substrate could provide a useful tool to improve alkalinity tolerance of gerbera plants under $NaHCO_3$ stress.
Culture in peat-perlite (1: 1) mixture produced better or similar yield and flower quality compared to soil. The performance of gerberas in perlite culture was intermediate while in pumice was the lowest, though satisfactorily (Fakhri et al., 1995).
The accumulation in the substrate of a high concentration of elements in the area of roots influences the quality of the flowers (Toma et al., 2017). These remain small, undeveloped.
The use of super-absorbent polymers as well as organic worm products improves the physico-chemical properties of growth media, Cocopeat, Perlite, Vermiculite leading to plant growth and flower yield in gerbera cv. 'Yosemite' (Verma et al., 2019; Drăghici and Jerca, 2017).
Both high and low temperatures and light in summer and winter influence the production and quality of gerbera flowers (Berninger, 1979; Aragón et al., 1984; Panter et al., 2016).
The objective of this study was to determine the effect of different substrates on growth and yield of gerbera under an open soil-less production system. We studied the effect of five types of substrate on growth and flowering of gerbera.

## MATERIALS AND METHODS

The experiment was carried in greenhouse conditions at University of Agronomic Sciences and Veterinary Medicine of Bucharest, Romania. We used three gerbera cultivars: 'Dune', 'Blind Date' and 'Balance'.

Figure 1. 'Dune', 'Blind Date' and 'Balance'

The types of substrate used for every cultivars were following: V1 - peat with pH 4; V2 - peat with pH 5.5; V3 - perlite 100%; V4 - 50 % perlite + 50%, peat with 4 pH; and V5 - 50% perlite + 50% peat with pH 5.5. We used 3 plants/replicates on every variant in block randomized. Planting was done in pots with a capacity of 4 L filled with substrate according to experimental variants. We recorded the amount of water and nutrient solution administered, we watched in dynamics the vegetative growth of the plants, the number of leaves and the height as well as the number of flowers formed on the plants. The care work consisted of watering, fertilization, temperature and light monitoring. Plants were fertilized with a same nutrient solution. Electrical conductivity of nutrient solution was 1.6 mS and pH 5.5.
In a period of 8 months, some quality and quantity characteristics of plants and flowers were recorded such as number of leaves, number of flower, flower stem height, flower diameter, stem diameter. All data for growth and flowering parameters were recorded and processed statistical using analysis of variance and means were compared by Duncan's Multiple Range Test (Steel et al., 1996). The temperature from greenhouse was 20-33°C and relative humidity were 50-60%.

## RESULTS AND DISCUSSIONS

In May, the number of leaves on the plants was different depending on the variety and the type of substrate. The lowest number of leaves was recorded for the 'Dune' variety of 3.5 leaves on the perlite substrate and the highest for the 'Balance' variety grown on the perlite substrate (Figure 2).

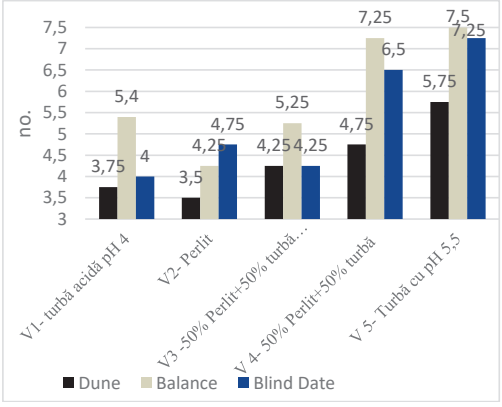


Figure 2. Number of leaves on plant in May

Figure 3. 'Dune' gerbera plants - in Mayâ

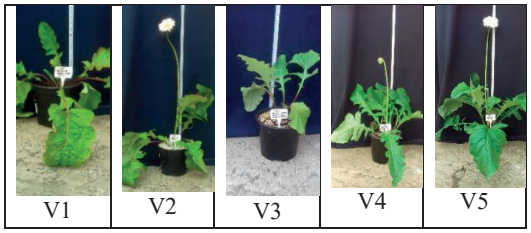


Figure 4. 'Balance' gerbera plants - in May

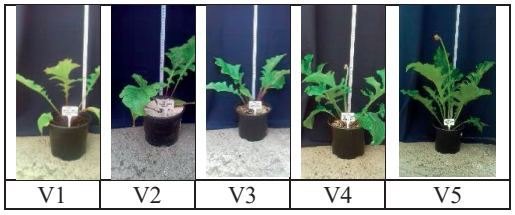


Figure 5. Gerbera 'Blind Date' plants - in May

If we analyze the behavior of the varieties according to the type of substrate we found that in the case of peat substrate with pH 4 (V1) for the 'Balance' variety the lowest average total number of leaves was 9 on plant with a percentage of 78.03% below the average of the varieties calculated on each substrate variant. In the case of variant 5 we also found that the 'Dune' variety showed the highest number of leaves compared to the 'Blind Date' and 'Balance' varieties (Table 1).

Table 1. Number of leaves on plant

| Variants | Dune | Blind Date | Balance | Average | Dune | Blind Date | Balance |
|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | Percent to average | | |
| V1 | 12.6 | 13 | 9 | 11.53 | 109.25 | 112.72 | 78.03 |
| V2 | 12.25 | 8 | 10.5 | 10.25 | 119.51 | 78.05 | 102.44 |
| V3 | 12.2 | 6 | 5.5 | 7.90 | 154.43 | 75.95 | 69.62 |
| V4 | 16.6 | 10 | 8 | 11.53 | 143.93 | 86.71 | 69.36 |
| V5 | 20.2 | 7 | 12 | 13.07 | 154.59 | 53.57 | 91.84 |

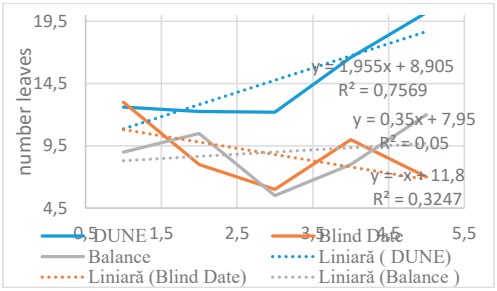


Figure 6. Number of leaves on plants

In the cultivated varieties, the correlations made between the number of leaves formed on the plant and the type of substrate showed insignificant relations in the case of the 'Balance' variety ($R^2$ = 0.05) and very significant in the case of the 'Dune' cultivar ($R^2$ = 0.7569) (Figure 6).

Based on the data recorded in the experimental variants regarding the number of leaves formed on plant we found that the varieties behaved differently when grown on different substrates. Thus, analyzing the total number of leaves, we noticed that in the 'Dune' variety a higher number of leaves were formed in the case of all substrate variants, these being 12.2 leaves at V3 and 20.2 leaves at V5. In the case of this variety we found that compared to V5 taken as a control, all experimental variants showed a lower number of leaves of 60.4% in V3 and 82% in V4. In the 'Balance' cultivar we also noticed that as a percentage the number of leaves in the experimental variants was below the control variant. In the case of the 'Blind Date' cultivar, we noticed that the largest number of leaves was formed in plants grown on acid peat substrate, the percentage being 85.7% above the control variant (Table 2).

Table 2. The number of leaves on plant and the percentage differences to the control variant

| Type of substrate | 'Dune' | | 'Blind Date' | | 'Balance' | |
|---|---|---|---|---|---|---|
| | No. | % to control | No. | % to control | No. | % to control |
| V1 | 12.6 | 62.4 | 13.0 | 185.7 | 9.0 | 75.0 |
| V2 | 12.3 | 60.6 | 8.0 | 114.3 | 10.5 | 87.5 |
| V3 | 12.2 | 60.4 | 6.0 | 85.7 | 5.5 | 45.8 |
| V4 | 16.6 | 82.2 | 10.0 | 142.9 | 8.0 | 66.7 |
| V5 | 20.2 | 100.0 | 7.0 | 100.0 | 12.0 | 100.0 |

V1 - peat pH 4; V2 - Perlite; V3 - 50% Perlite+50% peat; V4 - 50% Perlit+50% peat; V5 - Peat pH 5.5 (Ct)

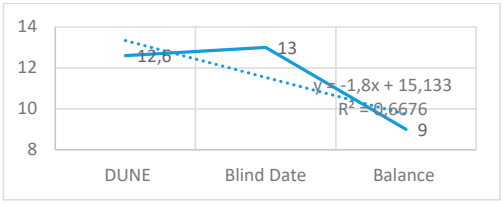


Figure 7. Influence of the peat with pH 4 substrate on the number of leaves formed on the plants

Analyzing the influence of the type of substrate on the average number of leaves formed on cultivars we found a significant correlation of $R^2 = 0.6676$ (Figure 7).

In the case of V2, perlite substrate, we found smaller relationships between cultivated varieties, this being $R^2 = 0.1678$ (Figure 8).

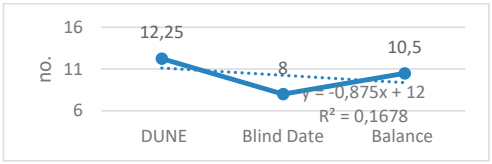


Figure 8. Influence of perlite substrate on the number of leaves formed on the cultivars

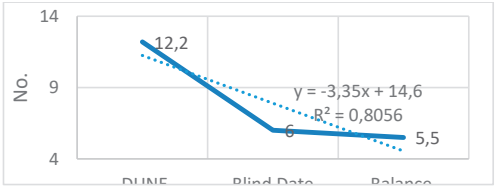


Figure 9. Influence of 50% Perlite+50% acid peat substrate on the number of leaves formed on the cultivars

Correlations between the number of leaves formed on plants at all cultivars grown on substrate of 50% Perlite+50% peat 4 pH and 50% Perlite+50% peat 5.5 pH indicated significant relationships of $R^2 = 0.8056$ at V3 respectively of $R^2 = 0.9129$ at V4 and slightly significant at V5 of $R^2 = 0.3785$ (Figures 9, 10 and 11).

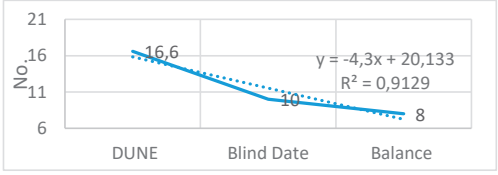


Figure 10. Influence of substrate with 50% Perlite+50% Peat with pH 5.5 on the number of leaves formed on the cultivars

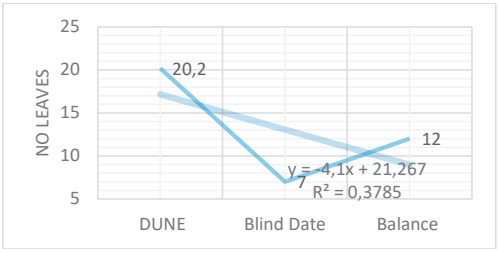


Figure 11. Influence of substrate - Peat with pH 5.5 on the number of leaves formed on the cultivars

The length of the leaves varied between 27.24 cm for the 'Dune' variety at V1 and 31.11 cm at V5. In the 'Blind Date' variety, the leaves were between 31 cm at V3 and 46 cm at V4. At the 'Balance' cultivar, the length of the leaves was 34 cm at V1 and 44 cm at V4. (Table 3).

By varieties, there were slightly significant relationships to the 'Dune' variety $R^2 = 0.4469$ (Figure 12).

Table 3. The average length of gerbera leaves on cultivars and the percentage compared to the average on variant

| Variant | Dune | Blind Date | Balance | Average | Dune | Blind Date | Balance |
|---|---|---|---|---|---|---|---|
| | cm | cm | cm | cm | % | % | % |
| V1 | 27.24 | 34.00 | 38.00 | **33.08** | 82.35 | 102.78 | 114.87 |
| V2 | 29.59 | 46.00 | 39.00 | **38.20** | 77.47 | 120.43 | 102.10 |
| V3 | 26.51 | 31.00 | 48.00 | **35.17** | 75.38 | 88.14 | 136.48 |
| V4 | 30.13 | 45.00 | 39.00 | **38.04** | 79.20 | 118.29 | 102.51 |
| **V5** | **31.11** | **38.00** | **44.00** | **37.70** | **82.51** | **100.79** | **116.70** |

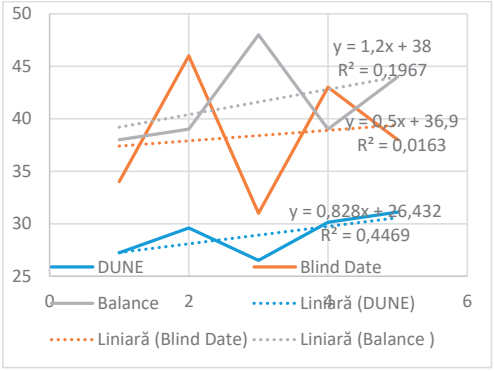


Figure 12. The influence of the substrate and the cultivars on the length of the leaves

Analyzing the average number of flowers formed on plant in the three cultivars, we found that they reacted differently depending on the type of substrate. We noticed that the 'Dune' cultivar grown on acid peat substrate pH 4 (V1) showed the lowest number of flowers formed on plant of 0.4 flowers / plant followed by the 'Blind Date' variety with 1.0 flowers / plant at V3 and the 'Balance' cultivar behaved very well on this type of substrate forming on average 4.5 flowers / plant (V1).

All gerbera cultivars grown on perlite (V2) substrate formed a large number of inflorescences on plants of 4.4 flowers in the 'Dune' variety, 5.3 flowers in the 'Balance' variety and l6.2 flowers in the 'Blind Date' variety. Analyzing the influence of the substrate type, we found that the correlation coefficients were for the 'Blind Date' cultivar R2 = 0.3535, for 'Balance' 0.0066 and for 'Dune' $R^2 = 0.2392$ (figures 13).

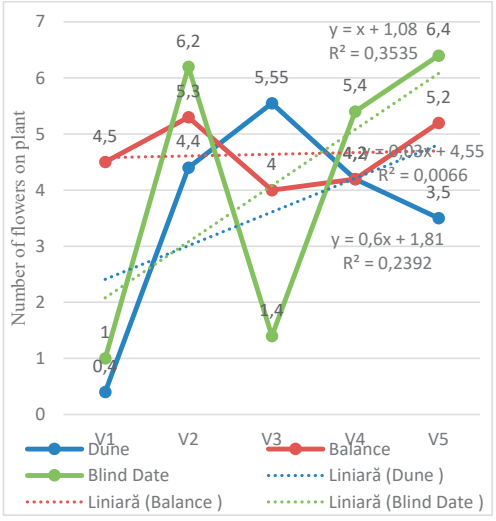


Figure 13. The influence of the type of substrate on the number of flowers per plant

In the 'Dune' variety, the number of flowers formed on plant in the first year of cultivation between May and October was on average 0.4 flowers at V1 with a difference statistically distinct negative very significant. Differences positive distinct very significant were registered at V3 where the highest number of flowers on plant of 5.5 was obtained where the percentage compared to the control was with 58.57% higher (Table 4).

Table 4. Number of flowers on plant at 'Dune' cultivar

| VARIANT | Number (no.) | Difference (no.) | | Significance (%) |
|---|---|---|---|---|
| V( 0 ) Average | 3.61 | 0.11 | 103.14 | N |
| V( 1 ) | 0.40 | -3.10 | 11.43 | OOO |
| V( 2 ) | 4.40 | 0.90 | 125.71 | * |
| V( 3 ) | 5.55 | 2.05 | 158.57 | *** |
| V( 4 ) | 4.20 | 0.70 | 120.00 | N |
| **V( 5 )** | **3.50** | **0.00** | **100.00** | **Control** |

DL5% = 0.800 DL5% in % = 22.8571
DL1% = 1.170 DL1% in % = 33.4286
DL0.1% = 1.750 DL0.1% in %= 50.0000

In the case of the 'Balance' cutivar, the total number of flowers on plant was 4.0 in V3 with a statistically negative significance and 4.5 flowers in V1 with a statistically insignificant significance.

Table 5. Number of flowers on plant at 'Balance' cultivar

| VARIANT | Number (no.) | Difference (no.) | | Significance (%) |
|---|---|---|---|---|
| V( 0 ) Average | 4.64 | -0.56 | 89.23 | N |
| V( 1 ) | 4.50 | -0.70 | 86.54 | N |
| V( 2 ) | 5.30 | 0.10 | 101.92 | N |
| V( 3 ) | 4.00 | -1.20 | 76.92 | O |
| V( 4 ) | 4.20 | -1.00 | 80.77 | N |
| **V( 5 )** | **5.20** | **0.00** | **100.00** | **Control** |

DL5% = 1.040 DL5% in % = 20.0000
DL1% = 1.520 DL1% in % = 29.2308
DL01% = 2.280 DL01% in %= 43.8461

In the case of the 'Blind Date' cultivar the number of flowers in average formed on plant was 6.4 flowers at V5 control and 1.4 flowers at V3 respectively 1.0 at V1, these indicating significantly distinct negative from statistical point of view (Tables 6).

Table 6. Number of flowers at 'Blind Date' cultivar

| VARIANT | Number (no.) | Difference (no.) | | Significance (%) |
|---|---|---|---|---|
| V( 0 ) average | 4.08 | -2.32 | 63.75 | OOO |
| V( 1 ) | 1.00 | -5.40 | 15.63 | OOO |
| V( 2 ) | 6.20 | -0.20 | 96.88 | N |
| V( 3 ) | 1.40 | -5.00 | 21.88 | OOO |
| V( 4 ) | 5.40 | -1.00 | 84.38 | O |
| V( 5 ) | 6.40 | 0.00 | 100.00 | control |
| DL5% = | 0.780 | DL5% in % = | | 12.1875 |
| DL1% = | 1.140 | DL1% in % = | | 17.8125 |
| DL01% = | 1.710 | DL01% in %= | | 26.7188 |

In the case of the 'Dune' variety, we found that, for the substrate variant where we used peat

(V1), no flowers formed in May, June, July and August, but only in September. The height of the floral stem was 33 cm. In the case of the rest of the substrate variants, we recorded heights of 40.5 cm at V5 and 54.5 cm at V2. The lowest heights of floral stems were recorded at V4 - a mixture of 50% perlite + 50% peat with pH 5.5 in July, August and September. Compared to the 'Balance' and 'Blind Date' varieties, the 'Dune' variety obviously reacted to the high values of temperatures during July-August above 34ºC and low relative humidity below 50%. It should be noted that on the peat substrate with a pH of 5.5 the flower stalks had heights of 40.5 cm in May and 60 cm in August (Figure 14).

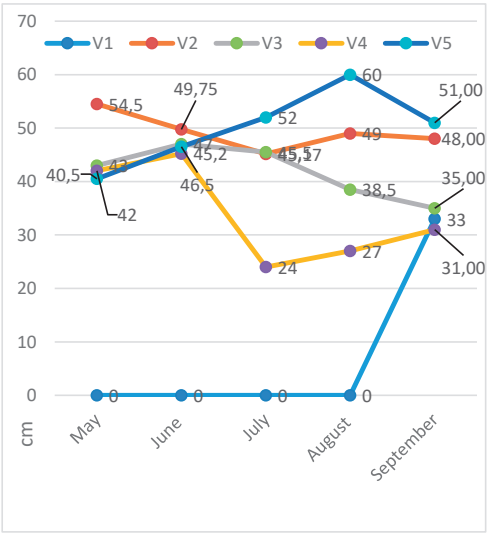


Figure 14. Inflorescence height during May-September at 'Dune' cultivar

In the case of the 'Balance' variety, we found that the height of the floral stem was relatively constant in May to September in the case of substrates V5, V3 and V1 and varied greatly in the perlite substrate (V2). It should be noted that at V1 substrate - acid peat with a pH of 4 flower stalks had the lowest heights of 12 cm in August and 14 cm in July (Figure 15).

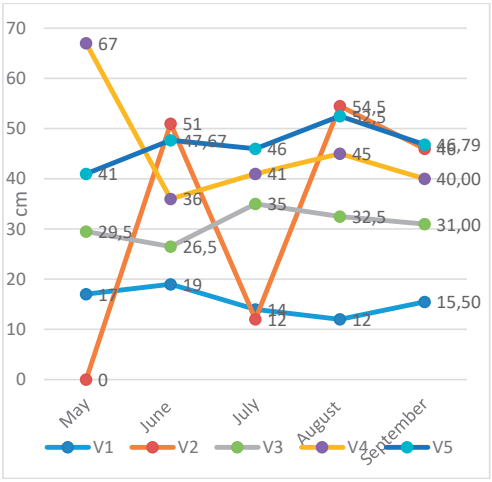


Figure 15. Inflorescence height during May-September at 'Balance' cultivar

In the case of the 'Blind Date' cultivar no flowers formed in May on all types of substrate also in June on V1, in July. In variant 3, no flowers were registered in July and August. In the case of this variety the longest floral stems were obtained. 52.66 cm at V4 in July and smallest of 24.6 cm at V2 in June (Figure 16).

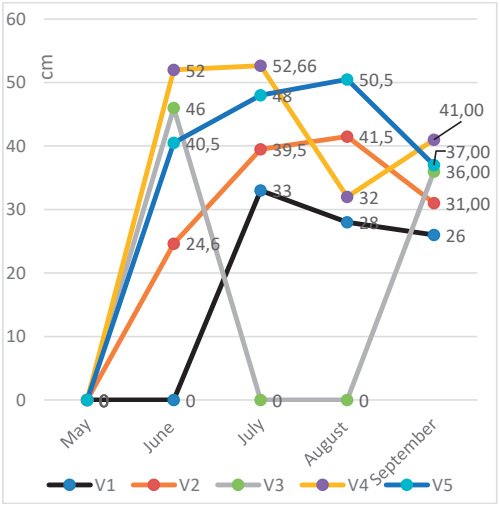


Figure 16. Inflorescence height during May-September at 'Blind Date' cultivar

The table 7 shows the average data on the height of the floral stem by variety and the type of substrate.

Table 7 Influence of inflorescence height on varieties and months and type of substrate

| Cultivar | Var. | May | June | July | Aug. | Sept. |
|---|---|---|---|---|---|---|
| 'Dune' | V1 | 0 | 0 | 0 | 0 | 33 |
| 'Balance' | V1 | 17 | 19 | 14 | 12 | 15.50 |
| 'Blind Date' | V1 | 0 | 0 | 33 | 28 | 26 |
| 'Dune' | V2 | 54.5 | 49.75 | 45.17 | 49 | 48.00 |
| 'Balance' | V2 | 0 | 51 | 12 | 54,5 | 46 |
| 'Blind Date' | V2 | 0 | 24.6 | 39.5 | 41.5 | 31.00 |
| 'Dune' | V3 | 43 | 47 | 45.5 | 38.5 | 35.00 |
| 'Balance' | V3 | 29.5 | 26.5 | 35 | 32.5 | 31.00 |
| 'Blind Date' | V3 | 0 | 46 | 0 | 0 | 36.00 |
| 'Dune' | V4 | 42 | 45.2 | 24 | 27 | 31.00 |
| 'Balance' | V4 | 67 | 36 | 41 | 45 | 40.00 |
| 'Blind Date' | V4 | 0 | 52 | 52.66 | 32 | 41.00 |
| 'Dune' | V5 | 40.5 | 46.5 | 52 | 60 | 51.00 |
| 'Balance' | V5 | 41 | 47.67 | 46 | 52.5 | 46.79 |
| 'Blind Date' | V5 | 0 | 40.5 | 48 | 50.5 | 37.00 |

We notice that on the peat substrate with pH 4 (V1) the 'Balance' variety behaved best but the height of the floral stems was the lowest.

On the perlite substrate (V2) the 'Dune' cultivar behaved very well presenting floral stems in all months. On the substrate of 50% perlite and 50% acid peat the 'Dune' presented the largest floral stems and the 'Balance' formed smallest floral stems of 26.5 cm in June and 32.5 cm in August but 'Blind Date' formed floral stems of 46 cm in June and 36 cm in September. In the case of substrate 50% peat with pH 5.5 + 50% perlite (V4), the flower stalks had lower heights in July and August for the '*Dune*' variety and heights of 41 cm in July and 67 cm in May. The 'Blind Date' variety presented floral stems in June-September of 32 cm in August and 52.66 in July. The best substrate variant for stem height was presented by variant 5 (peat with pH 5.5).

The 'Dune' cultivar formed uniform inflorescences, with a diameter between 9.5 cm and 9.6 cm in variant 3. The lowest values were recorded for the substrate type of V4 (Figures 17, 18).

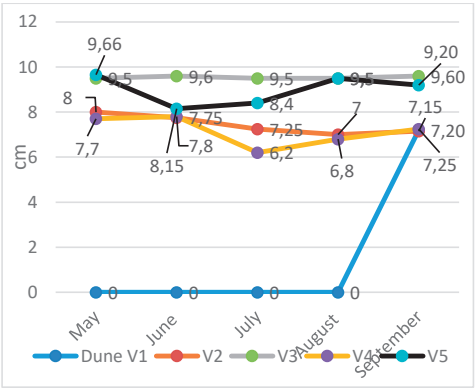


Figure 17. The diameter of inflorescences at 'Dune' cultivar

Figure 18. 'Dune' cultivar

In the 'Balance' variety, the diameter of the flowers showed the lowest values in May (5.75 cm) in the case of cultivation on acid peat substrate but also in the rest of the months, it being between 7 cm in June and 8 cm in the July and August. On the perlite substrate, the diameter of the flowers was approximately uniform, being between 9.15 cm in June and August (Figures 19, 20).

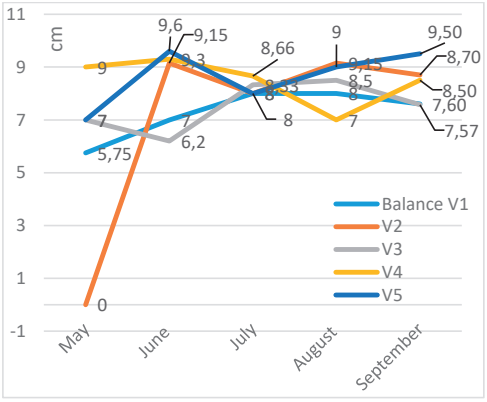


Figure 19. The diameter of inflorescences at 'Balance' cultivar

Figure 20. *'Balance'* *'Blind Date'*

In the case of the 'Blind Date' cultivar, we noticed flowers with a larger diameter compared to the rest of the analyzed cultivars. We obtained flowers with a large diameter between 9.33 cm in August and 10.38 cm in September, in variant 4. The culture substrate had influenced the diameter of the flower it varied from one month to another (Figure 21).

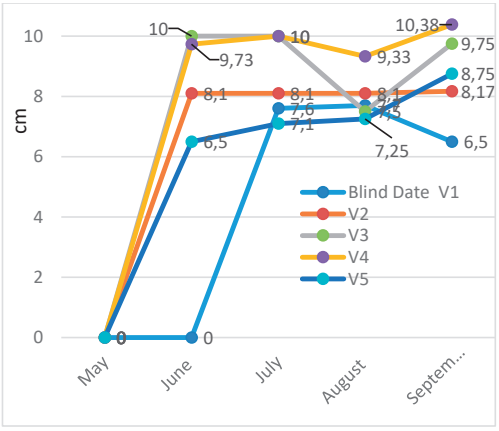


Figure 21. The diameter of inflorescences at 'Blind Date'

## CONCLUSIONS

The number of leaves on the plants was different depending on the variety and the type of substrate. It was lower in gerbera plants grown on perlite substrate but also in 'Dune' varieties grown on all types of substrate in the early stages of growth. After 9 months of cultivation, the lowest number of leaves was recorded in the 'Balance' variety between 5.5 leaves at V3 and 12 leaves at V5. Also, the number of leaves per plant at 'Blind Date' was lower compared to the 'Dune' variety. At the 'Dune' variety we recorded the highest number of leaves at V5 of 20.2 leaves and 12.25 leaves at V2.

The length of the leaves varied from cultivar to cultivar. In the 'Dune' variety the number of leaves was 26.51 cm at V3 and 31.11 cm at V5. The 'Blind Date' variety presented leaves with a length between 31.00 cm at V3 and 46 cm at V2. In the case of the 'Balance' variety, the leaf length was the largest between 38 cm at V1 and 48 cm at V3.

The number of flowers per plant was relatively constant for the 'Balance' variety in May-September, being between 4 flowers / plant at V3 and 5.2 flowers/plant at V5. The 'Blind Date' variety showed the greatest reaction to the type of substrate.

The height of the flower stalk was different depending on the variety, but it differed a lot in some varieties depending on the very high temperatures during the summer.

The diameter of the flowers was smaller for the 'Dune' variety in the case of variant 4 and almost constant for V5. In the 'Balance' variety, the diameter of the flower was 5.75 at V1 and 7.6 cm at V5. Flowers with the largest diameter were obtained from the 'Blind Date' variety.

The culture substrate had influenced the diameter of the flower it varied from one month to another.

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