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GROWTH AND FLOWERING PERFORMANCE EVALUATION OF TEN POTTED *CHRYSANTHEMUM* CULTIVARS

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Abstract

Chrysanthemum is one the most important flower crops commercially grown for cut flower, loose flowers, bedding and pot plants. Along with ensuring optimal culture conditions, an appropriate nutrition regime and the application of appropriate management, the most important factors on which the success of a chrysanthemum containerized culture depends are: the choice of suitable varieties for containerized culture, high-quality planting material. In order to diversify the current Chrysanthemum assortment and to promote of the most valuable cultivars for containerized culture, an experiment was conducted to evaluate the growth and flowering performance of ten Chrysanthemum cultivars, in greenhouse conditions. From the data presented, taking into account both flowering phenology and morphological characters, decorative features, the best varieties within the studied Chrysanthemum assortment were Meridian White and Sumbeam Pink Bicolor.

Key words*: Chrysanthemum, cultivars, flowering, growth, potted plants.*

INTRODUCTION

Chrysanthemum is the most important flower crop in the Asteraceae family, a multiple-use plant that has a market value ranking second highest among ornamental species following the rose (Shinoyama et al., 2012).

Chrysanthemums are used either as cut flowers or grown in pots and the success in cultivation of this plant is principally due to the great diversity of species and cultivars, suitability in different cultivation systems and the possibility of cultivation all over the year (Uddin et al., 2015).

Chrysanthemum morifolium Ramat. Tzvel, the most remarkable taxon of *Chrysanthemum*, originated in China, is a medicinal, food and ornamental plant (Hao, 2022).

As an ornamental plant, it is found in the most diverse forms, with flowers that cover almost the entire range of known colors with the most varied sizes and shapes, from single to double, wrapped, stellate, globular.

The erect and tall growing types (standard chrysanthemums) are grown as cut flowers for making bouquets and vase decoration the dwarf and compact growing types (spray chrysanthemums) are cultivated as pot plants for beautifying indoors and outdoors spaces (Singh & Chettri, 2013).

Advancement in pot *Chrysanthemum* varietal development and production technology permits its year-round production in most parts of the world, in greenhouses by managing environmental conditions. Along with ensuring optimal environmental conditions, an appropriate nutrition regime and the application of appropriate management, the most important factors on which the success of a chrysanthemum container culture depends are: the choice of suitable varieties for container culture, high-quality planting material.

Today, more and more private producers are focusing on growing chrysanthemums in pots to be used in the fall. In this regard, the preference of varieties will be provided according to the period in which it is desired to obtain pots with well-developed and flowering plants to have a commercial appearance (Cantor et al., 2020). A potted chrysanthemum can be considered good when it has a good shape, compact appearance, relatively low height, abundant and long-lasting flowering. For choosing the good cultivars, varietal performance has previously evaluated on different crops like *Gerbera* (Petra et al., 2020), *Gladiolus* (Azimi, 2020, Nicu & Manda, 2022, Swaroop et al., 2022), *Tagetes* (Narsude et al., 2010, Shivakumar et al., 2015), *Lisianthus* (Hasib et al, 2017), *Hemerocallis* (Bahrim et

al., 2020), *Hosta* (Aelenei et al., 2020) and all of these crops showed variations in their performances. Many studies for this purpose have also been carried out on *Chrysanthemum* (Roude, 1991, Bala, 2015, Uddin et al., 2015 Suvija et al., 2016, Parmar et al., 2019, Cantor, 2020, Patil et al., 2022, Prakash & Fatmi 2022, Priya & Singh 2022, Singh et al., 2022).

In Romania, nowadays, the cultivated areas with *Chrysanthemum* are developing quickly through potted cultures which have gained a significant increase. Also, due to the progress made in the selection of chrysanthemums, many cultivars have been introduced in the recent plant assortment. The knowledge of the morphology and biology of the new cultivars is very important because can be recommended varieties that will be adequate to the Romanian local conditions (Cantor, 2020). In order to diversify the current assortment and to promote of the most valuable cultivars for containerized culture, an experiment was conducted to evaluate the growth and flowering performance of ten *Chrysanthemum* cultivars, in greenhouse conditions.

MATERIALS AND METHODS

The study was carried out in 2020, in Daneti township, Dolj county, in a chrysanthemum protected culture, established on 01.06.2020, in a solar with a surface of 500 m, under natural light conditions. The climate is temperate-continental in Daneti and it is characterized by very hot summers, with low rainfall and moderate winters. In 2020, the average annual temperature was 13.6°C and the amount of annual rainfall was 690.1 mm.

Plant material was represented by ten medium vigor *C. morifolium* Ramat. cultivars: Daybreak Sweet Pink (DSP), Daybreak Purple (DP), Daybreak Bright Yellow (DBY), Meridian White (MW), Meridian Bronze (MB), Sunbeam Flame (SF), Sunbeam Pink Bicolor (SPB), Sunbeam Coral (SC), Chrystal Misty Purple (CMP), Gigi Snow (GS) (table 1).

Table 1. Description of of *Chrysanthemum* varieties studied

Daybreak sweet pink	Daybreak purple	Daybreak bright yellow	Sunbeam flame	Sunbeam pink bicolor	Sunbeam coral	Meridian white	Meridian bronze	Chrystal misty purple	Gigi snow
									
Flowering time									
very early	very early	very early	early	early	early	mid season	mid season	mid season	Mid season
Flower color									
pink	purple	yellow	bronze golden	pink bicolor	red	white	bronze	pink	white
Plant vigor									
medium	medium	medium	medium	medium	medium	medium	medium	medium	medium

Cuttings purchased from import (certified planting material) on 27.04.2020, from Dummen Orange Group, were used to establish the culture. These were planted for rooting in jiffy pills. The percentage of rooting was assessed two weeks after the establishment of cultures and was 100%.

After rooting, the cuttings were planted in 10.5 cm pots and a phosphorus-based fertilizer was applied. After three weeks, the first pinch was performed at 4-5 leaves from the surface of the substrate. After another 2 weeks, the first treatment with growth retardants (B-Nine 85, 0.3%) was applied, and the second at the appearance of flower buds. After 20-25 days (01.06.2020), when they exceeded the diameter of the pot, the plants were transplanted into the culture pots (18 cm diameter), in a mixture of peat + perlite (3:1) in which Osmocote was incorporated and the drip system was installed.

In the first month of cultivation, the green Universol fertilizer was used, and after the plants exceeded the diameter of the pot, the blue Universol 18+11+18 was introduced, for about 40 days until the appearance of the first flower buds. Two Universol yellow 12+30+12 and Peters fertigations were applied at the appearance of buds and after the appearance of

flower buds, Universol base was used until the completion of the culture. All other cultural practices were kept uniform for all treatments in the experiment. Throughout the vegetation period, the main phenophases were followed: the beginning of flowering, the mass flowering, the end of flowering. Based on the phenology data, the following were calculated: the number of days from the establishment of the culture to the beginning of flowering, the duration of the flowering, the number of days from the establishment of the culture to marketing stage.

The morphological and ornamental characteristics determined were: plant height, plant diameter, number of shoots, internode length, number of leaves/shoot, leaf length, number of flowers/shoot, flower head diameter. The plant height, internode length, and number of leaves was recorded at flowering stage. Due to excessive growth, the cultivars Chrystal Misty Purple and Gigi Snow were removed from the study, as they lost their decorative appearance.

The experiment was laid out in Completely Randomized Design with three replications. The data were statistically analyzed using the one-way analysis of variance (ANOVA) and means were separated using the Tukey's pairwise comparisons at a significance level of $p \leq 0.05$ using the MINITAB package system.

RESULTS AND DISCUSSIONS

Considering the commercial importance of this crop, there is a necessary to evaluate cultivars for their vegetative, flowering and quality characters for the purpose of identification of suitable cultivars for specific regions.

The study was conducted to evaluate the performance of some *Chrysanthemum* cultivars in respect to their different traits.

Analyzing Table 2, it follows that the beginning of flowering was triggered the earliest in the varieties Daybreak Sweet Pink, Meridian White, Sunbeam Flame, 64-66 days after the establishment of the culture, followed by the varieties Sunbeam Pink Bicolor, Daybreak Purple which bloomed after 71-75 days, and the varieties Daybreak Bright Yellow, Meridian Bronze, Sunbeam Coral bloomed after 77-81 days from the establishment of the culture.

Also, there is observed a staggered flowering within the analyzed assortment, which includes varieties with early (Daybreak Sweet Pink, Daybreak Bright Yellow, Sunbeam Flame), medium (Daybreak Purple, Sunbeam Pink Bicolor, Sunbeam Coral) and late flowering (Meridian White, Meridian Bronze) (Table 2).

Table 2. The main phenophases of *Chrysanthemum* varieties studied

Cultivar	Flowering			Marketing stage	Days to beginning of flowering	Duration of flowering (days)	Time to marketability (days)
	Beginning of flowering	Full flowering	End of flowering				
DSP	03.08	20.09	08.10	20.08	64	66	81
DP	14.08	27.09	10.10	17.08	75	56	78
DBY	04.08	20.09	01.10	12.08	65	58	73
SF	05.08	12.09	04.10	20.08	66	60	81
SPB	10.08	17.09	12.10	12.08	71	63	73
SC	15.08	23.09	10.10	20.08	78	59	81
MW	20.08	24.09	13.10	25.08	81	64	86
MB	16.08	21.09	16.10	20.08	77	61	81
Mean	03-20.08	12-27.09	01-13.10	12-25.08	72.12	60.87	79.25
SE	-	-	-	-	1.82	0.85	1.20
SD	-	-	-	-	6.04	2.83	3.99

*DSP-Daybreak Sweet Pink, DP-Daybreak Purple, DBY-Daybreak Bright Yellow, SF-Sunbeam Flame, SPB-Sunbeam Pink Bicolor, SC-Sunbeam Coral, MW-Meridian White, MB-Meridian Bronze.

The longest duration of flowering was recorded in Daybreak Sweet Pink (66 days) followed by Meridian White and Sunbeam Pink Bicolor (64 days, 63 days respectively) and the shortest flowering period corresponds to the Daybreak Purple cultivar (56 days). Compared to the average of all the varieties (60, 87 days), lower values were obtained for the Daybreak Purple, Daybreak Bright Yellow, Sunbeam Flame and Sunbeam Coral (56-60 days). The difference in the flowering duration may be due to the varietal character, environmental factors, habitat type and genetic makeup of the varieties. Similar results were reported in *Chrysanthemum* by Balaji & Reddy (2004) and Srilatha et al. (2015).

The number of days from establishment to marketable stage was between 73 days

(Daybreak Bright Yellow, Sunbeam Pink Bicolor) and 86 days (Meridian White). Intermediate values were recorded at Daybreak Purple (78 days) and at Daybreak Sweet Pink, Meridian Bronze, Sunbeam Flame and Sunbeam Coral (81 days) (Table 2).

The observations and the measurements achieved concerning the main morphological characteristics of *Chrysanthemum* cultivars studied are presented in the Table 3. Plant height presented statistically significant variation, the range of plant height was from 50.60 cm to 58.63 cm. The tallest plant was found from Sunbeam Flame (58.63 cm) followed by Sunbeam Coral (58.17 cm), whereas Daybreak Purple, recorded the lowest plant height of 50.6 cm. All the cultivars exceeded the criterion for acceptable plant height established for potted plants, which is from 1.5 to 2.5 times pot height (Sitawati & Ni'mah, 2021). Moreover, the varieties Chrystal misty purple and Gigi snow were eliminated from the study, because they lost their decorative appearance due to exaggerated vegetative growth. As a result, cuts were applied followed by additional treatments with growth retarders, which no longer allowed their comparison with the other varieties studied. As mentioned by Sitawati & Ni'mah (2021), depending on the growth rate of chrysanthemum varieties, the number and frequency of treatments with daminozide is different: fast-growing cultivars required daminozide application three times, moderate-growing cultivars required once daminozide application, and slow-growing cultivars does not require the application of PGR to produce a chrysanthemum height to the suitable size standard for potted plants. Therefore, further studies are needed to investigate the effects of PGR application on chrysanthemum cultivars grown in pots. Qureshi et al. (2018) mention that 2 applications at four weeks after planting and at flower initiation with 8000 ppm daminozide, does not meet the quality standard for several types of potted chrysanthemums; a single application of daminozide did not produce significant results, but the second and subsequent applications may reduce plant height. It could be concluded that it is necessary to more study the effect of PGR application on chrysanthemum cultivars grown in pots.

The results revealed that the highest plant diameter was recorded in Sunbeam Flame (64.46 cm), followed by Sunbeam Coral (60.05 cm) and Meridian white (60.00 cm), while the Sunbeam Pink Bicolor have registered the smallest increases in the diameter of the plant of 55.76 cm. The average diameter of the plant in Sunbeam Flame was significantly higher compared to all the other varieties analyzed.

No significant differences were found between cultivars regarding the number of branches per plant which ranged from 4 branches/pl (Daybreak Purple, Sunbeam Pink Bicolor) and 4.83 branches/pl in the Sunbeam Flame cultivar. Intermediate values were recorded for other varieties, ranging from 4.20-4.67 branches/pl. These results were confirmed by Meilasari et al. (2021) who showed that by pinching the apical buds in chrysanthemum cultivars grown in pots, 3-4 lateral shoots are expected to grow.

The length of the internode varied between 2.83 cm in the Sumbeam Pink Bicolor variety and 3.43 cm in the Daybreak Bright Yellow variety, with other varieties recording intermediate values between 3.1-3.2 cm. Compared to the average of all the varieties (3.15 cm), the Daybreak Sweet Pink, Daybreak Purple, Daybreak Bright Yellow, and Sunbeam Pink Bicolor varieties had lower values ranging from 2.83-3.13 cm. The lack of correlation between plant height and internode length is explained by the difference in the number of nodes (Table 3).

The average number of leaves per shoot and the average leaf size are also important parameters for evaluating container-grown chrysanthemum varieties. A large number of leaves per plant is reflected in the compact appearance and commercial value of the variety. There were significant differences between cultivars for average number of leaves per shoot. The highest value of this parameter corresponds to the Sunbeam Flame variety (83 leaves), followed by Meridian White (81.3 leaves), and the lowest value was recorded for the Daybreak Purple variety (58.3 leaves), which also had the lowest height. Compared to the average of the varieties (73.07), lower values were obtained

for the Daybreak Purple and Meridian Bronze varieties.

In terms of the average leaf length, the analysis of the data shows that the highest value was recorded at the Meridian White (5.23 cm), followed by Daybreak Sweet Pink (5.20 cm) while the lowest value was recorded for the Daybreak Purple variety (4.53 cm). The average leaf length in Meridian White was significantly higher compared to Daybreak Purple cultivar. Compared to the average of all the varieties (4.91 cm), lower values were obtained for the varieties Daybreak Purple, Sunbeam Coral, Sunbeam flame and Meridian Bronze (4.53 cm, 4.67 cm, 4.78 cm, 4.90 cm respectively).

Table 3. Performance of *Chrysanthemum* cultivars for morphological characters

Cultivar	Plant height (cm)	Plant Diameter (cm)	Number of branches/pl	Internode length (cm)	Number of leaves/shoot	Leaf length (cm)
DSP	52.00±6.03 ab	57.76±1.36 bc	4.56±0.40 a	3.10±0.10 ab	75.20±2.43 b	5.20±0.26 ab
DP	50.60±1.68 b	56.53±0.98 c	4.00±0.23 a	3.03±0.20 ab	58.33±1.52 c	4.53±0.30 b
DBY	52.86±1.80 ab	58.33±1.53 bc	4.20±0.34 a	3.13±0.12 ab	76.00±9.29 a	5.00±0.20 ab
SF	58.63±1.52 a	64.46±1.28 a	4.83±0.28 a	3.43±0.11 a	83.00±3.00 a	4.78±0.25 ab
SPB	54.70±2.52 ab	55.76±0.68 c	4.00±1.00 a	2.83±0.15 b	72.73±1.42 b	5.00±0.20 ab
SC	58.17±1.76 a	60.05±1.32 b	4.50±0.50 a	3.27±0.11 a	74.60±5.03 b	4.67±0.30 ab
MW	55.20±0.80 ab	60.00±1.00 b	4.67±0.58 a	3.17±0.15 a	81.46±1.86 a	5.23±0.12 a
MB	55.86±1.20 ab	58.67±1.15 bc	4.33±0.58 a	3.27±0.15 ab	63.57±3.11 bc	4.90±0.26 ab
Mean	54.79	59.04	4.49	3.15	73.07	4.91
SE	0.71	0.57	0.11	0.042	1.78	0.06
CD	3.46	2.78	0.53	0.20	8.75	0.31

* Means within rows using different letters are differ significantly at the P value ≤ 0.05 levels; **DSP-Daybreak Sweet Pink, DP-Daybreak Purple, DBY-Daybreak Bright Yellow, SF-Sunbeam Flame, SPB-Sunbeam Pink Bicolor, SC-Sunbeam Coral, MW-Meridian White, MB-Meridian Bronze.

The average number of flowers per shoot was determined at the time of maximum flowering and includes both open flowers and buds formed. The values for this parameter varied within a wide range, ranging from 29 flowers/ shoot for Sunbeam Coral to 48.3 flowers/shoot for the Meridian White variety, the difference being statistically ensured (Table 4).

Table 4. Performance of *Chrysanthemum* cultivars for flowering parameters

Cultivar	Number of flowers/shoot	Diameter of heads (cm)
DSP	45.30±2.52 ab	5.30±0.26 a
DP	38.60±1.51 b	4.87±0.30 ab
DBY	41.50±2.18 ab	5.03±0.25 ab
SF	38.90±3.76 b	5.10±0.36 ab
SPB	44.40±4.06 ab	4.90±0.36 ab
SC	29.00±1.50 c	4.60±0.40 ab
MW	48.50±1.50 a	5.10±0.43 ab
MB	43.26±2.97 ab	4.30±0.25 b
Mean	42.42	4.89
SE	0.83	0.08
SD	4.07	0.43

*Means within rows using different letters are differ significantly at the P value ≤ 0.05 levels (using one way analysis)

Compared to the average of all the varieties (4.91 cm), lower values were obtained for the Daybreak Purple, Sunbeam Coral, Sunbeam flame and Meridian Bronze varieties (4.53 cm, 4.67 cm, 4.78 cm and 4.90 cm respectively).

The average diameter of head recorded the highest value in Daybreak Sweet Pink (5.3 cm), followed by the Sunbeam Flame and Meridian White (5.1 cm), and the lowest value it was recorded for the Meridian Bronze variety (4.3 cm). Compared to the average of all the varieties (4.89 cm), lower values were obtained for the Daybreak Purple, Sunbeam Coral and Meridian Bronze (4.3-4.87 cm).

CONCLUSIONS

Based on the observations it can be concluded that in container-grown chrysanthemum cultivars, shorter plant height, shorter internodes, and a higher number of heads per plant can be advantageous for vegetative growth. The different cultivars exhibited significant variations in most parameters. No significant differences were observed in the number of shoots per plant. All the cultivars exceeded the plant height criterion established for potted plants. The Daybreak Sweet Pink, Meridian White, and Sunbeam Pink Bicolor

cultivars had the longest flowering duration, while the Daybreak Purple cultivar had the shortest. The Meridian White and Sunbeam Pink Bicolor varieties performed best in most parameters, including plant size, early flowering, average number of heads per plant, and duration of flowering, followed by the Daybreak Sweet Pink cultivar.

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