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MORPHOLOGICAL AND PHENOLOGICAL VARIABILITY OF SOME VARIETIES OF GLADIOLUS CULTIVATED UNDER CLIMATIC CONDITIONS OF CRAIOVA

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Abstract

The study was carried out to evaluate the variability of some morphological characteristics in six cultivars of gladiolus, 'Blue Frost', 'Green Star', 'Nova Lux', 'Peter Pears', 'Priscilla' and 'Purple Flora', cultivated in the climatic conditions of Craiova city, Romania. The results showed that the minimum number of days from planting to flowering and the maximum plant height, number of leaves per plant and spike length were recorded in 'Green Star' cultivar, which was superior to the other cultivars. 'Nova Lux' performed the best for the number of florets per spike (16.5), and 'Blue Frost' for the diameter of floret (12.26 cm), wich are important quality indicators. Among the cultivars 'Purple 'Flora' and 'Priscilla' had the longest flowering duration. The coefficient of variation in terms of vegetative and flowering parameters, ranged between 7.75% for the number of leaves per plant and 19.89% for the number of florets in inflorescence. The highest coefficient of variation was obtained for the flowering duration (23.73%).

Key words: *cultivar, flowering duration, morphological characteristics.*

INTRODUCTION

Gladiolus (*Gladiolus hybridus* Hort.) is a perennial geophyte plant, belonging to the Iridaceae family, and it is especially valuated for the beauty and elegance of the inflorescences. It is cultivated in many countries both in the field and in greenhouses, depending on the local climatic conditions. It is one of the most important commercial flower crops, with a high economic value, for cut flower and corm production. There are numerous gladiolus cultivars today on the world market, which distinguish by the great diversity of sizes, shapes and colours of flowers, the number of flowers in a spike, the length of floral stems, the resistance to diseases and pests, as well as vase life duration of cut flowers. The majority of cultivars used for cut flower production have long spikes with large florets.

Gladioli present round or flat underground stems (corms), covered with fibrous, brownish tunics. During the vegetation period, 1-2 vigorous flower stems develop from axillary buds on the corms, and are wrapped at the base in a few leaves and have various heights, depending on the variety and corm size. During every growing season, the plants produce one new corm on top of the old corm, which is consumed and disappears until autumn, and numerous cormels develop at the base of the new corm. The leaves are long, narrow, lanceolate or linear, green, with obvious veins and the appearance of a sword. The flowers are arranged in spike-like inflorescences, they are funnel-shaped, with a straight, wavy or fringed edge, and a very wide range of colours in different attractive shades, from white, pink, red, yellow, orange to purple, violet and even green or colour combinations. Choudhary et al. (2011), Patra & Mohanty (2014) showed that spike length, number of florets per spike, floret size, weight and diameter of corm are important quality characteristics and may be considered as selection indices in gladiolus breeding programme and crop improvement. The cultivars that produce a high yield of cut flowers and increased rate of corms production are the most appreciated and looked for by producers and consumers.

Gladiolus can be grown with good results in sandy-loam, rich in nutrients, loose, well drained soils, with constant moisture and pH 6-7, in sunny sites. Ahmad et al. (2013) reported the beneficial effects of humic acid and NPK applications on vegetative growth, yield and commercial quality of cut gladiolus stems.

Baldotto & Baldotto (2013) reported that the plants produced a higher number of florets per spike and a higher number of cormels, with a larger diameter, which may be due to the effects of humic acid application.
The nitrogen, phosphorus, potassium with micronutrients especially boron and zinc had a significant effect on size, weight and number of corms and cormels increasing (Halder et al., 2007; Shaukat et al., 2012).
Environmental factors such as temperature and light intensity control the growth and development of plants, which are closely dependent on climatic conditions (Dole & Wilkins, 2005). Nagar et al. (2017) reported an increase in the vegetative and quality parameters of the plants grown under higher temperature and long day conditions. Zeshan et al. (2016) studied the growth and development of three cultivars of gladiolus under different ecological conditions and concluded that temperature is an important factor for the vegetative growth, the variety-climate interaction being significant. Gladiolus plants are sensitive to water stress, which results in reduced flower yields (Wilfret, 1992).
Gladioli are vegetatively propagated through corms and cormels for commercial production. The corm size is a determining factor in plant growth and the quality of the flowers (Narayan et al., 2013; Azimi, 2020). The date of planting plays an important role in improving the vegetative growth, quality and corm production. The different planting dates have a significant effect on the number of days to corm sprouting and affect floral characteristics and number of florets/spike (Zubair et al., 2006; Akpinar & Bulut, 2011; Saaie et al., 2011; Adil et al., 2013). *In vitro* protocols have been developed for the mass production of gladiolus cormels, using different media and various explants of the plant (Memon et al., 2016).
Several studies have been conducted regarding the influence of plant growth regulators on growth, flowering and gladiolus corm production and it has been reported that the treatments with different growth regulators are effective in the breaking of corm dormancy and promote more number of quality corms and earlier sprouting (Baskaran et al., 2009; Bhujbal et al., 2014), as well as an increase in plant height, flower quality parameters and the chlorophyll content (Chopde et al., 2012b; Sajid et al., 2015).
Gladiolus are mainly used as cut flowers, in bouquets and floral arrangements, but can also be used alone or in combination with other perennial and annual species, in simple or mixed borders, in groups, for the summer decoration of parks and gardens, as well as in pots and containers, in patios or balconies.
The study was conducted to determine the morphological and phenological variability of six cultivars of gladiolus, under the climatic conditions of Craiova city, located in the southwest of Romania.

MATERIALS AND METHODS

The research was carried out in the Floriculture Research Area, Faculty of Horticulture from Craiova, Romania, on six cultivars of gladiolus with a different range of floret colours from light lilac with white (‘Blue Frost’), light green (‘Green Star’), yellow (‘Nova Lux’), orange (‘Peter Pears’), white with pink edges (‘Priscilla’) to dark purple (‘Purple Flora’), grown in open field conditions. The biological material consisted of medium sized corms imported from The Netherlands, which were planted in April 2018, as soon as the temperatures began to rise, at a spacing of 30 cm between rows, 15 cm between corms along the row and the depth of 10 cm, in moist, loam-sandy soil. Cultural practices have been applied during the vegetation period.
The climate is temperate-continental with Mediterranean influences in Craiova city and it is characterized by very hot summers, with low rainfall and moderate winters. In 2018, the average annual temperature was 12.3°C and the amount of annual rainfall was 725.1 mm.
The experiment was laid out in randomized complete block design with three replications. Observations and biometric measurements on the main phenological phases and morphological characteristics were made during the study period. The growth parameters (number of days to sprouting, plant height, number of leaves per plant, leaf length) and flowering parameters (number of days from planting to flowering, number of florets per inflorescence, spike length, floret diameter,

duration of flowering) were recorded and analysed statistically using descriptive statistics in Minitab 17 software.

RESULTS AND DISCUSSIONS

The phenological stages of gladiolus plants are divided into four developmental phases: corm dormancy phase, sprouting, vegetative phase and reproductive phase (Schwab et al., 2015). The initial phases of plant growth are affected by local climatic conditions such as temperature and rainfall.

In the present study, the different cultivars have shown various responses with respect to the analysed morphological characteristics.

In Table 1 there are shown the results obtained for the vegetative features. The sprouting percent was 100% in all the studied cultivars and the average number of days required for sprouting of the plants was between 9.13 and 15.86. Among the cultivars, 'Priscilla' had the earliest sprouting (9.13 days), while 'Peter Pears' recorded the maximum number of days from corm planting to sprouting (15.86), followed by 'Purple Flora' with 14.23 days.

Regarding the plant height, a difference was observed among the studied cultivars. The highest value was recorded in the 'Green Star' cultivar (132.51 cm), while the 'Blue Frost' had the lowest value of this parameter (102.33 cm). Many cultivars behave differently even grown under the same environmental conditions. The corms used in this study had about the same size, so the variation observed in plant height of gladiolus cultivars might be due to the environmental conditions and genetic traits. Hossain et al. (2011) reported a wide variation in plant height amongst some genotypes of gladiolus. The height of the flowering stem is one of the important traits for the cut flower trade.

The maximum number of leaves per plant was recorded in 'Green Star' (8.43) and a similar result was reported by Naresh et al. (2015) and Pattanaik et al. (2015), followed by 'Purple Flora' (8.12), while the 'Peter Pears' cultivar had the minimum number of leaves (6.75). In terms of the average leaf length, the analysis of the data shows that, the lowest value was recorded at 'Peter Pears' (52.56 cm), compared to the other cultivars. The highest value of this parameter was recorded at the 'Priscilla' cultivar (69.83 cm), which is in accordance with the results of Kumar & Kulkarni (2009), wich obtained similar values for the leaf length as well as for the number of leaves.

The coefficient of variation (CV) was low for the number of leaves per plant (7.75%), the plant height (9.47%) and medium for the length of leaves (12.00%). The highest coefficient of variation was recorded for the number of days to sprouting, and indicates differences from one cultivar to another. This aspect may be due to the genotypic differences, that may contribute to the various levels of gibberellins and abscisic acid in corms, which is controlling the dormancy period (Kaur & Bajpay, 2019).

Table 1 Vegetative characteristics of gladiolus cultivars

Cultivars	Number of days to sprouting	Plant height (cm)	Number of leaves/plant	Leaf length (cm)
Blue Frost	12.45	102.33	7.33	54.21
Green Star	9.26	132.51	8.43	58.40
Nova Lux	11.93	127.53	7.87	67.62
Peter Pears	15.86	123.42	6.75	52.56
Priscilla	9.13	125.16	7.66	69.83
Purple Flora	14.23	110.78	8.12	66.24
Mean	12.14	120.29	7.69	61.48
SD	2.67	11.39	0.59	7.38
CV%	22.00	9.47	7.75	12.00

In Table 2 are presented statistical data on morphological characteristics of the studied cultivars. Analysing the average values obtained for each cultivar, it was observed that the lowest number of days from corm planting to flowering correspond to 'Green Star' cultivar (78.45) and the highest number of days to flowering was recorded in 'Purple Flora' (101.60). The others cultivars ranged between 80.45-98.12 days taken to first floret open after planting. The planting depth of the corms and the distance between the plants play an important role in the number of days until the opening of basal florets (Niranjan et al., 2018). Variation in the number of days required for first floret opening might be attributed to the genetic constitution of cultivars which respond to the vegetative and reproductive growth and to the other factors such as water, light and nutrition (Thakur et al., 2015).

The spike length, the number of florets per inflorescence and the diameter of florets at full opening are important quality indicators for the decorative and commercial value of gladioli.

The maximum spike length was recorded at 'Green Star' (66.23 cm), and the minimum length was recorded at 'Blue Frost' (47.20 cm), the average value for this parameter being 55.80 cm. Sharma & Gupta (2003) revealed that spike length was significantly improved by increasing size of mother corms and planting spacing.

The number of florets/spike was influenced by cultivar and ranged from 9.60 at 'Purple Flora' to 16.50 at 'Nova Lux'. Kumar et al. (2017) reported that cv. 'Nova Lux' produced the maximum number of florets per spike (15.53). The 'Peter Pears' cultivar produced an average number of florets/spike of 14.33, the finding being in line with the result obtained by Singh et al. (2020). The diameter of floret was measured on the flowering stem and had the maximum value at 'Blue Frost' (12.26 cm), followed by 'Priscilla' (12.14 cm) and the minimum values at 'Green Star' (9.41 cm) and 'Nova Lux' (9.78 cm). Kumar (2015) reported a similar value of the diameter of floret for the 'Nova Lux' cultivar. Naresh et al. (2015) recorded similar values to those obtained in this study, for the number of days taken for basal floret to fully open, the spike length and the floret diameter, at 'Green Star' cultivar. The variation in the number of florets per spike, the flower diameter and spike length may be due to genetic variability among the different cultivars of gladiolus and prevailing environmental conditions during the field experiment (Safeena & Thangam, 2019).

It is important to know the flowering time of the cultivars, for a staggered flowering on a longer period. Duration of flowering in the field also varied depending on cultivar and it was between 9.33 days at 'Green Star' and 17.92 days at 'Purple Flora', with an average value of 13.61 days. The coefficient of variation was medium for the floret diameter (11.06%), the spike length (13.30%) and the number of florets per spike (19.89%). The high coefficient of variation (23.73%) was recorded for the flowering duration.

Table 2. Flowering characteristics of gladiolus cultivars

Cultivars	Number of days to flowering	Duration of flowering (days)	Number of florets/spike	Length of spike (cm)	Diameter of floret (cm)
Blue Frost	98.12	11.42	10.43	47.20	12.26
Green Star	78.45	9.33	13.81	66.23	9.41
Nova Lux	93.67	12.26	16.50	62.67	9.78
Peter Pears	90.18	14.27	14.33	53.45	10.33
Priscilla	80.45	16.48	12.67	55.73	12.14
Purple Flora	101.60	17.92	9.60	49.50	10.82
Mean	90.41	13.61	12.89	55.80	10.79
SD	9.36	3.23	2.56	7.42	1.19
CV%	10.35	23.73	19.89	13.30	11.06

CONCLUSIONS

Regarding the emergence of plants, the results obtained show that it started after a certain number of days from corms planting that is specific to each cultivar, the dormancy period of corms varying from one cultivar to another, depending on the cultivar and environmental conditions. In the area where the experiment on evaluation of different cultivars has been carried out, the climatic conditions correspond to the ecological requirements both for gladioli and for many ornamental species. 'Green Star' was superior to the other cultivars in terms of the plant height, number of leaves and spike length and bloomed the earliest, after 78.45 days from planting. 'Nova Lux' had the maximum number of florets per spike and the highest diameter of floret was observed in 'Blue Frost' cultivar. The longest flowering duration was recorded in the 'Purple Flora' and 'Priscilla' cultivars.

All studied cultivars had vigorous, good quality stems, with over 100 cm height, and can be used both for cut flowers, especially valuated in bouquets and flower arrangements for their elegant spikes with attractive florets of various colours and shades, and in gardens during the summer season.

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