Scientific Papers. Series B, Horticulture. Vol. LXIV, No. 1, 2020
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

# EVALUATION OF VEGETATIVE DEVELOPMENT AND DECORATIVE BEHAVIORS OF SOME GLADIOLUS (*GLADIOLUS HYBRIDA* L.) VARIETIES UNDER BULGARIAN CONDITIONS

**Valentin PANCHEV, Valeria IVANOVA, Nikolay PANAYOTOV**

Agricultural University of Plovdiv, 12 Mendeleev Blvd., Plovdiv, Bulgaria

Corresponding author email: valentin_panchev@abv.bg

***Abstract***

*The main goal of the present study was to establish the most appropriate gladiolus variety for growing under Bulgarian conditions. The experiment carried out in the Experimental fields of Agricultural University - Plovdiv with five gladiolus varieties: Purple flora, Priscilla, Plum tart, Oscar and Green star. The corms were planted in March. The phenological phases of sprouting, the appearance of the inflorescence stalk, beginning and end of flowering were observed. During the vegetation, the most important vegetative behaviours of the plant as high of plant, the diameter of the stem, number of leaves, length of inflorescence stalk and numbers of fully developed flowers and undeveloped flowers per plant were established. The coluor of the flowers was also registered. A Green star and Purple flora varieties have the strongest vegetative development, resulting in the formation of the highest plants, with the largest diameter and number of leaves. The highest decorative value of all tested genotypes, under the conditions of Bulgaria, indicated the Purple flora variety. Positive correlations are established between the height of the plant and the number of leaves and also for the length of inflorescences stalk and the number of developed flowers.*

***Key words****: flower crops, flowering, decorative value, phenophases, corms.*

## INTRODUCTION

Gladiolus is one of the main flower crops, widely distributed for both cultivations of cut flowers and inclusion in outdoor landscaping groups. The diversification of the varieties in this crop is significant, and in this regard, it is important to carry out research to identify suitable varieties depending on the specific climatic and soil conditions. One successful way to get new genotypes according to Denisa et al. (2012) is an inter-species hybridization. As a result, the breeders from the Cluj-Napoca, Romania region have received over ten new well-established hybrids suitable for outdoor cultivation. Pragya et al. (2010) studied an extremely large collection of 54 genotypes of gladiolus. Based on the study of nine major morphological features and the application of 225 random amplified polymorphic DNA (RAPD) markers amplified with 25 arbitrary primers, they estimate the genetic relationships between the selected genotypes. In Bulgaria is also carried out breeding programs with gladiolus. Ivanova et al. (2019) reported for new Bulgarian gladiolus variety named Iva and emphasized that this variety excided the other traditional cultivars from this flower crop and has very high decorative values.

Meira et al. (1990) examined *in vitro* regeneration by using the explants from the inflorescence of the gladiolus stalks and established the new plantlets within 6-7 weeks. The regeneration depended on the levels of growth substances added to the basal medium and the best combination for organ initiation is observed in the medium with 10 ppm naphthalene-acetic acid and 0.5 ppm of kinetin.

By the experiments conducted by Kamble et al. (2004) with nine varieties of gladiolus, the earliest development and flowering is manifested the Snow White variety. The emergence was established in 58.20 days and flowering began at 66.70 days. Good results were also noted for the American Beauty variety. The latest development was observed in the cultivar Cultivars Magic. Shillo and Halevy (1996) emphasize the importance of specific climatic conditions for the normal development of gladiolus. An important factor, according to the authors, is the presence of optimum light, especially sensitive the plants

are in phase 4-6 sheets. The researcher emphasized that insufficient light in the initial periods delayed development and delayed flowering, however, many test varieties subsequently overcome the delay.

Kaninski et al. (2012), intending to establish the impact of the specific conditions of the area, investigated different periods of the planting and established that, at later dates, flowering and plant development are significantly more rapid. In this scope, a similar investigation carried out also Ivanova et al. (2016) and established that the best period for the planting of gladiolus is the middle of April. Through a study of the timing of planting and the impact of GA3 Suman et al. (2012) indicate that the best results are obtained with the application of the gibberellic acid in a concentration of 100 ppm.

The main goal of the present study was to establish the most appropriate gladiolus variety for growing under Bulgarian conditions.

## MATERIALS AND METHODS

The experiments were carried out during the period 2017-2019 in the Experimental field of the Agricultural University of Plovdiv Bulgaria with the following five gladiolus cultivars: Purple flora, Priscilla, Oscar and Green star. The corms were planted during the last decade of March by the scheme 25 x 25 cm. The approved technology of gladiolus cultivation, developed by the Institute for Decorative and Healing Plants (Bistrichanov et al., 2008) has been implemented. During the vegetation, the necessary agro-technological practices were applied. The experiments were performed in four replicates, in a randomized method, with a plot size of 3 sq.m. and 48 plants were included.

The following phenophases were reported: emergence, beginning of the inflorescence stalk, beginning and end of flowering. The appearance of these phenophases was established when they occurred in 10% of the plants in a given phase (Dimova and Marinkov, 1999).

The diameter, height and weight of the corms before planting were measured on 15 corms. At the end of flowering the plant height, stem diameter, number of leaves, number of developed flowers, number of undeveloped flowers, as well as the color of flowers were established. Measurements were made on ten plants of each replicate. The percentage of developed plants towards the total planted corms number was also determined.

The data obtained were subjected to analysis of variance (ANOVA) using software package SSPS, developed by IBM Corporation (https://en.wikipedia.org/wiki/SPSS).

Due to the similarity of the trends in the obtained results, the presented data are averaged values from the three-year studies.

## RESULTS AND DISCUSSIONS

The genotypic differences between the studied varieties of gladiolus according to the morphological features of the corms were observed about the planting material (Table 1). The differences between the highest and lowest diameter of the corm of studied varieties are 1.0 cm. The values of this index ranged from 2.9 cm for the Oscar and Green star varieties to 3.9 cm for Purple flora. Smaller differences within 0.7 cm are reported for the corm height. It is the highest for the Plum tart variety, followed by the Oscar, 2.7 cm and 2.6 cm respectively, and the smallest one is for Priscilla. The most significant differences in corm morphology were observed for weight. This difference reaching to 13.42 g. Values range from 11.97 g (Green star) to 25.39 g (Purple flora). The results about the weight of corms are with statistical significance with the exception between Purple flora and Plum tart and also between Oscar and Green star.

The data of the phenological observations are presented in Table 2. The difference in the sprouting period between the tested varieties is relatively small and ranges from 27 to 31 days after the planted of the tubers. The earliest sprouting was reported for Priscilla on day 25, followed by Oscar on 27 days.

Table 1. Morphological features of the gladiolus corms

| Varieties | Diameter (cm) | Height (cm) | Weight (g) |
|---|---|---|---|
| Purple flora | 3.9 | 2.4 | 25.39 |
| Priscilla | 3.4 | 1.9 | 15.82 |
| Plum tart | 3.7 | 2.7 | 23.17 |
| Oscar | 2.9 | 2.6 | 12.38 |
| Green star | 2.9 | 2.1 | 11.97 |
| LSD p = 5.0% | 0.4 | 0.6 | 3.4 |

The most delayed sprouting was observed in the Plum tart variety, and it's was reported on 31 days. More variation is recorded in the next phenophase, the appearance of the inflorescence stalk. Earlier this phase was established in Purple flora, 18 days after sprouting. The differences between the earliest developed stalks, in the mentioned variety and the latest, formed one in Green star is 14 days. As vegetation progresses the differences between the studied genotypes increase. This is very clearly observed in the phase of the beginning of flowering. The earlier appearance of the inflorescence stalk in Purple flora also caused earlier flowering, as early as 90 days. The flowering is the latest for Priscilla, with a difference of 23 days from the earliest variety. A positive characteristic of the Purple flora variety, compared to the other varieties, is the later end of the flowering. Although the initial phases undergo more rapidly, the flowering reaches 182 days after planting or lasts 92 days. The shortest flowering period of 63 was observed for the Oscar variety, ending at 168 days from planting, i.e. the flowering period is only 63 days. The longest flowering occurs at Plum tart to 191 days or it in the period from 83 days. Ivanova et al. (2019) point out that for the conditions of Bulgaria the average duration of the flowering of gladiolus is within 50-60 days. This indicates that the tested varieties in this article there are longer flowering, which also makes them more promising for outdoor cultivation.

Table 2. Phenological beahviors of different gladiolus varieties (days after planting)

| Varieties | Sprouting | Appearance of the inflorescence stalk | Beginning of the flowering | End of the flowering |
|---|---|---|---|---|
| Purple flora | 28 | 46 | 90 | 182 |
| Priscilla | 25 | 48 | 113 | 178 |
| Plum tart | 31 | 52 | 108 | 191 |
| Oscar | 27 | 49 | 105 | 168 |
| Green star | 29 | 60 | 109 | 185 |
| LSD p = 5.0% | 3.1 | 2.3 | 2.8 | 2.1 |

There are no differences between the varieties in terms of the percentage of the developed plants (Figure 1).

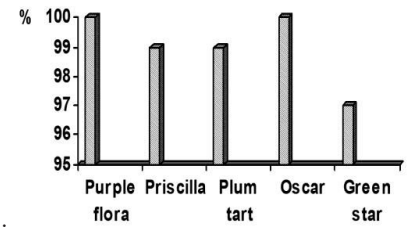


Figure 1. Percentage of the developed plants

Almost 100% is the development of plants in all varieties. Only Green star has a slight deviation and this percentage reaches 97. This may be due to the higher adaptability of these varieties under growing conditions.

Morphological features are important for a more complete assessment of plant development and genotype response (Table 3). The most essential indicator in this regard is the height of the plants.

The significance of this sign and as a decorative value also is emphasized by Kumari et al. (2011) and by Ivanova et al. (2019).

The highest plants were measured in the Green star variety - 132.1 cm. With the lowest height is characterized Oscar variety, with 31.9 cm less than the previous one. The plants of Purple flora are also relatively high. Statistical significance of the data was established.

Another vegetative feature describing plants of gladiolus is the diameter of the stem. This feature ranges from 1.7 cm (Plum tart) to 2.6 cm (Green star). The exceeding between the highest and the lowest values is 34.62%. Changes between the varieties are also observed for the number of leaves. With the highest number of leaves are the plants from Green star variety (9.3), followed by this one of Purple flora (9.0). The significantly smaller numbers of leaves developed the Priscilla and Plum tart varieties, respectively 6.5 and 7.2, or 43.07% and 29.16% lower than the values of this feature in Green star variety. The development of the leaves depends on strongly by the height of plants. This is confirmed from the established correlation coefficients that for many of the studied varieties determinate are high and positive correlation, except Plum tart and Green star, where it is positive but middle. The differences are mathematically proven.

Table 3. Morphological characteristics of the plant of several gladiolus varieties

| Varieties | Height of the plant (cm) | Diameter of the stem (cm) | Number of leaves | r |
|---|---|---|---|---|
| Purple flora | 127.8 | 2.5 | 9.0 | 0.66 |
| Priscilla | 120.4 | 1.9 | 6.5 | 0.77 |
| Plum tart | 115.2, | 1.7 | 7.2 | 0.35 |
| Oscar | 100.2 | 2.3 | 8.0 | 0.68 |
| Green star | 132.1 | 2.6 | 9.3 | 0.48 |
| LSD p = 5.0% | 4.1 | 0.6 | 1.0 | |

r - correlation coefficient between height of plant and number of leaves

The most important elements for describing varieties of flower crops are their decorative features (Table 4). The length of the inflorescence stalk plays an essential role in determining its quality and decorative behaviours. For the Green star variety, it indicates the highest value among the genotypes tested and reaches 36.6 cm. Very close to it are the gladiolus of Purple flora with the height of the stalk from 36.5 cm. The inflorescence stalk in Plum tart (24.4 cm) and Priscilla (27.3 cm) are significantly lower. The data of the height of the inflorescence stalk are statistically significant, except for those between Purple flora and Green star.

The decorative value of flowering species is primarily determined by the number of flowers developed. This number is the highest for Purple flora - 14.5. It is 16% lower for Green star, with 12.5 pcs flowers. At the least flowers were developed the plant from Priscilla and Plum tart. The number of flowers is directly related to the length of the inflorescence stalk, which is very clear in the last two mentioned genotypes, which were noted that they are with the lowest inflorescence stalk. This tendency is observed also by the established correlation coefficients between this parameter and the number of flowers. The high and positive correlation is determinate for Purple flora, Plum tart and Oscar with r = 0.63, r = 0.68, and r = 0.67, respectively. For the other two varieties, the correlation is also positive but middle. The genotypic response in gladiolus is also appropriate to determine depending on the number of the set but undeveloped flowers. The least undeveloped flowers are count in Plum tart variety - 2.9 pcs. However, it must emphasize that this variety has formed a few fully developed flowers and the part of undeveloped is high, reaching 31.86%. With the low number of a developed and high number of undeveloped flowers is characteristic also Priscilla variety and the portion of undeveloped is 52.22%. The most abundant flowering, as mentioned above has Purple flora variety, and part with it the share of undeveloped flowers is the lowest - 22.06%, followed by Green star - 28.0%. A very important feature is the colour of the flowers, as it completely determines the decorative value of the gladiolus. The colour diversity of the flowers in tested variety is wide. The predominant are the flowers with purple colour and hue. It should be noted that lime-green colour is less common, as is the case with Green star, making it a non-standard and therefore very interesting and beautiful compared to the widespread gladiolus varieties.

Table 4. Decorative behaviors of the gladiolus varieties

| Variety | Length of the inflorescences stalk (cm) | Number of developed flowers | Number of undeveloped flowers | r | Colour of flowers |
|---|---|---|---|---|---|
| Purple flora | 35.5 | 14.5 | 3.2 | 0.73 | Dark purple |
| Priscilla | 27.3 | 9.0 | 4.7 | 0.47 | White-pink |
| Plum tart | 24.4 | 9.1 | 2.9 | 0.68 | Purple-violet |
| Oscar | 31.0 | 11.2 | 3.6 | 0.67 | Velvety red |
| Green star | 36.6 | 12.5 | 3.5 | 0.43 | Lime-green |
| LSD p = 5.0% | 2.4 | 1.2 | 0.6 | | |

r - correlation coefficient between height of plant and number of leaves

## CONCLUSIONS

The corms between the different gladiolus genotypes differ in morphological features. With the largest diameter and weight are characterized by those of the Purple flora variety.

The tested varieties of gladiolus are varied slightly on the term of sprouting, and more significant differences there are in the appearance of inflorescence stalk and the flowering. The longest flowering period is in Plum tart variety, from 83 days.

A Green star and Purple flora varieties are with the strongest vegetative growth, resulting in the development of the highest plants, with the biggest diameter and number of leaves.

The highest decorative value of all tested gladiolus genotypes, under the conditions of Bulgaria, was manifested by Purple flora variety, which is with the highest length of the inflorescence stalk and the number of developed flowers and a low proportion of undeveloped flowers.

## REFERENCES


Bistrichanov, S., Ivanova, I., Kaninski, A. (2008). Technology for cut flower production in gladiolus in the open, approved by the Expert Council of the Academy of Agricultural Science. Protocol №14/10.04.2008 (Bg).

Denisa, H. O. R. A., Cantor, M., Erzsebet, B. U. T. A., Andriescu, I. (2012). Researches regarding intraspecific hybridization of Gladiolus L. species in order to obtain novel ornamental varieties. Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture, 69(1).

Dimova, D., E. Marinkov (1999). Experimental design and biometry, Publish house of Agricultural University-Plovdiv, 65-79 (Bg).

Ivanova, Iv., Ivanova, V., Dimitrov, D. (2016). Influence of planting data on growth and cut flowers of gladiolus. Dcoratyviuju ir sodo augalu sortimento, technologiju ir aplinkos optimizimizavis Mokso darbai, vol. 7(12), 142-145.

Ivanova, I., Kaninski, A., Galeva, A. (2019). Iva - new gladiolus variety. Rastenievadni nauki, 56(5), 8-11.

Kamble, B. S., Reddy, B. S., Patil, R. L. T., Kulkarni, B. S. (2004). Performance of gladiolus (*Gladiolus hybridus* Hort.) cultivars for flowering and flower quality. Journal of Ornamental Horticulture, volume 7, Issue 3 and 4, 51-56.

Kaninski, A., Ivanova, I., Galeva, A., 2012. Ekaterina – New Bulgarian variety, Plant science. XLIX, No 3, 64-67.

Kumari, S., Patel, B. S., Mahawer, L. N., 2011. Influence of gibberellic acid and planting date on growth and flowering in gladiolus cv. Yellow Frilled. Journal of Horticultural Sciences, Vol. 6 No. 2, 114-117.

Meira, Z., Halevy A. H., Shilo, R., 1990, Organs and Plantlets Regeneration of Gladiolus through Tissue Culture., Annals of Botany Company, Volume 34, Issue 3, 671–676.

Pragya, K., Bhat,V., Misra, R. L., Ranjan, J. K., 2010. Analysis of diversity and relationships among Gladiolus cultivars using morphological and RADP markers. Indian Journal of Agricultural Science, 80(9), 766-72.

Shillo, R. A., Halevy, H., 1996, The effect of various environmental factors on flowering of gladiolus. I. Light intensity. Scientia Horticulturae,Volume 4, Issue 2, , Pages 131-137.