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Research Article

Effects Of Different Planting Times and Corm Sizes on Plant Growth, Development, and Flower Production Of Gladiolus (*Gladiolus grandiflorus*) under Sanliurfa Conditions

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Abstract

The aim of the present study was to determine the effect of different planting times and corm sizes on plant growth, development, and flower yield in Gladiolus. The Red Beauty variety was used as the study material. In the study, two corm sizes (10–12 and 12–14 cm) and five different planting times (April 1, April 15, May 1, May 15, and June 1) were used. The sprouting time (day), flowering time (day), plant height (cm), number of leaves (number/plant), length of the flower stem (cm), length of the spike (cm), number of florets (number/spike), thickness of the flower stem (mm), diameter of the new corm (cm), circumference of the new corm (cm), number of new corms (number/plant), weight of new corm (g/plant), number of cormels (number/plant) and weight (g/plant) and corm yield (g/plot) were determined. We determined that the planting times indicated were suitable for cultivation under Sanliurfa conditions in terms of yield and quality. The best Gladiolus cultivation times in Sanliurfa varied, but the best results were obtained from large corms (12–14 cm). As the temperature increased, corm growth times increased, and plant height, number of leaves, new corm weight, and cormel number and weight decreased. The maximum flowering time and parcel yield were obtained from the fifth planting (June 1), the longest spikes, maximum number of florets, maximum number of cormels and greatest cormel weight, and greatest plant height were determined from the first and second planting times. There was no significant difference between planting times for the other investigated parameters. The large corms (12–14 cm) were observed to be better than small corms (10–12 cm) for increases in most of the parameters investigated.

Keywords: *Gladiolus* spp., planting time, corm size, yield, quality

INTRODUCTION

Gladiolus species are herbaceous plants in the Iridaceae family with a bulbous body (corm), longitudinal grooved leaves closing on each other, and a spiked flower structure. In Latin, “gladiolus” means “sword” (Duygu et al., 1982; De Hertogh and Le Nard, 1993). The plant grows in Asia, Europe, and the tropical regions of South Africa, and the genus contains approximately 250 different species (Mengüç, 1996; Zencirkıran, 2002). Gladiolus was brought to Europe from South Africa in 1737. Many varieties were bred in Belgium, England, and Netherlands, and the production began in North America in the 1870s (Mengüç, 1996). Gladiolus spp. is a bulbous plant with an important commercial value and widely cultivated in many countries worldwide (Singh et al., 1998). It is among the top 10 species worldwide used in the cut-flower trade (Anonymous, 2014). Gladiolus spp. are ornamental plants widely sought in the market because of the length of its flowering season, high durability of the cut flowers, and vivid and varied colors (Altan and Altan, 1997). The production volume of Gladiolus, which ranked third after carnations and roses in Turkey in 2018, is 6,764,800 units (TUIK, 2019). Planting time is very important in Gladiolus production, quality, and flower yield. The most important factors that affect flowering are light, temperature, as well as the carbohydrate level, water balance, and the amount of mineral substance in the plant. Short-day conditions and decreased light intensity increase flower degeneration (Delpierre and Du Plessis, 1974; Altan and Altan, 1997; Gürsan et al., 1986; Cohen and Barzilay, 2001). Sanliurfa Province, Turkey, and its surroundings have suitable ecological conditions for growing ornamental plants in greenhouses and open fields. In fact, roses and orchids have been grown in greenhouses there for years. Considering that the ecology of the region may be suitable for Gladiolus cultivation, the aim of the present study was to determine the most appropriate planting time and corm size that affect Gladiolus flower yield and quality.

MATERIALS and METHODS

The present study was conducted during the 2019 summer production period at the Harran University Şair Nabi Campus Technopolis application and trial area to determine the effects of different planting times and corm sizes on Gladiolus sp. growth, development, and flower yield. In the study, corms of the Red Beauty variety in blooming maturity with 10-12 and 12-14 cm circumferences were used. Plots were divided into parcels such that the main plots were formed for different planting times and subplots were formed for corm size. Five plantings at 15-d intervals were completed on April 1 (first), April 15 (second), May 1 (third), May 15 (fourth), and June 1 (fifth). The corms were stored at 6°C until planting time, and those within each planting time were placed into an acclimation cabinet 15 d before planting. The temperature was increased by 2°C each day up to 20°C. After the corms were kept at 20°C for 1 week and prepared for planting, they were planted in the designated plots. Before planting, the production material was kept in a solution mixed with 4% Sportak and 2% Herodion for 10 min and dried for 1 d in a heap not exceeding 10 cm thick in a cool, shaded area. After the corms had dried, they were planted by hand in the designated plots at a distance of 30 cm between rows and 15 cm within rows, and a planting depth of 10 cm. The plots were 1.80 m long, with 4 rows of 12 plants per row. During the study, irrigation, hoeing, fertilization, and manual weed control were conducted as necessary. In plants, flowers, and corms, sprouting time, first flowering period (d), 70% flowering period (d), duration of flowering (d), plant height (cm), number of leaves (number/plant), spike length (cm), number of florets (number/spike) plant), thickness of flower stem (mm), number of flower stems (number/plant), new corm harvest time (d), number of new corms (number/plant), weight of new corms (g/plant/), diameter of new corms (cm), circumference of new corms (cm), number of cormels (number/plant), weight of cormels (g/plant), and corm parcel yield (g/plot) were determined. The study was arranged in a randomized block split plot design with three replications. The data were analyzed for variance analysis using MSTAT-C, and a comparison of the means was made using the least significant difference test.

RESULTS and DISCUSSION

Time of sprouting (day)

Planting time ($P < 0.01$) and corm size ($P < 0.05$) significantly affected plant sprout time. In this context, the earliest sprout times were from the second planting time (23.67 d) and large corms (26.19 d), while the latest sprout times were from the first planting time (33.83 d) and small corms (30.93 d) (Table 1). Rees (1972) has emphasized that although flowering in bulbous plant species depends on environmental conditions, the flowering time of year also depends on the plant's genetics. Korkut (1992) has indicated that the sprout time of the early planted corms was longer than that of later plantings. These results are in parallel with those of the present study.

Table 1. Effect of different planting times and corm sizes on Gladiolus emergence time, first flowering time, and 70% flowering time

Planting Time	Emergence Time			First Flowering Time			Time to 70% Flowering		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (April 1)	36.33	31.33	33.83[a]	94.00	93.33	93.67[b]	112.00	109.33	110.70[a]
2. DZ (April 15)	24.66	22.66	23.67[b]	83.00	81.33	82.17[c]	99.66	95.00	97.33[c]
3. DZ (May 1)	30.33	22.66	26.50[b]	86.00	83.66	84.83[c]	107.33	105.00	106.20[b]
4. DZ (May 15)	34.00	30.00	32.00[a]	95.00	90.33	92.67[b]	114.33	109.66	112.00[a]
5. DZ (June 1)	29.33	24.33	26.83[b]	104.00	98.00	101.00[a]	115.33	109.33	112.30[a]
Avg.	30.93[a]	26.19[b]		92.40	89.33		109.73[a]	105.66[b]	

Notes: DZ: Planting time; KY: small corm (10–12 cm); BY: large corm (12–14cm).

Initiation of flowering

We observed that different planting times had a significant ($P < 0.01$) effect on first flowering, while the effect of corm sizes was insignificant ($P > 0.05$). The latest flowering was from the fifth planting time (101.00 d) and small corms (92.40 d), while the earliest flowering was from the second and third planting times (82.17 and 84.83 d, respectively) and large corms (89.33 d) (Table 1). Keleş and Türkoğlu (2015), in their study on the effect of four different cultivars (Nova Lux, Purple Flora, White Swan, and Red Beauty) and three planting times (May 8, 8, May 23, and June 6) on the flowering period under Siirt ecological conditions, have found that the longest flowering period from the June 6 planting time (88.02 d) and the shortest flowering period from May 8 and May 23 planting times (78.79–77.09 d).

Duration until 70% flowering

The effect of different planting times ($P < 0.01$) and corm sized ($P < 0.05$) on 70% flowering time of the Gladiolus cultivars was statistically significant. The earliest 70% flowering was on April 15 (second planting) (97.33 d) and large corms (105.66 d); the latest 70% flowering was at the first, fourth, and fifth planting times (110.70, 112.00, and 112.30 d, respectively) and small corms (109.73 d) (Table 1). Yalcintas et al. (2011) have investigated the effect of planting times on flowering time in their study using 4 different planting times (May 31, June 15, June 30, and July 15) and 11 Gladiolus varieties. They have determined that the longest flowering period was at the fourth planting time (97.18 d) and, according to these results, the flowering period was also early in the early plantings, and the time taken for flowering increased with the progression of planting time toward the end of summer (Yalcintas et al., 2011).

Duration of flowering

The effects of planting times on flowering duration were statistically significant ($P < 0.01$), while the effects of corm size were insignificant ($P > 0.05$). With an increase in temperature and lighting, the progression of planting times toward the end of summer increased the time necessary for flowering. Accordingly, the maximum flowering duration was from the fifth planting (June 1) (130.20 d) and small corms (119.39 d), while the minimum flowering duration was observed from the second planting (April 15) (108.30 d) and large corms (117.39 d) (Table 2).

Table 2. Effect of different planting times and corm sizes on Gladiolus residence time, plant height, and number of leaves

Planting Time	Flowering Duration			Plant Height			Number of Leaves		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (April 1)	120.00	118.33	119.20[b]	89.80	95.00	92.40[a]	8.00	8.30	8.15
2. DZ (April 15)	109.00	107.66	108.30[d]	90.80	93.60	92.25[a]	8.00	8.00	8.00
3. DZ (May 1)	113.33	114.00	113.70[c]	89.10	91.10	90.17[ab]	8.00	8.30	8.15
4. DZ (May 15)	122.33	119.00	120.70[b]	88.70	89.60	89.20[bc]	8.00	8.60	8.13
5. DZ (June 1)	132.33	128.00	130.20[a]	84.30	90.00	87.17[c]	8.00	8.00	8.00
Avg.	119.39	117.39		88.50[b]	91.80[a]		8.00	8.24	

Notes: DZ: Planting time ; KY: small corm (10–12 cm); BY: large corm (12–14cm).

Plant height

Considering the average plant height after different planting times, the effect of planting times ($P < 0.01$) and corm size ($P < 0.05$) on plant height was statistically significant. The highest plants were observed from the first planting (April 1; 92.40 cm) and large corms (91.80 cm), while the shortest plants were observed from the fifth planting (June 1; 87.17 cm) and small corms (88.50 cm) (Table 2). We observed that plant height decreased as the planting dates (third, fourth, and fifth) progressed toward the summer months. Yalçıntaş (2011) and Akça (2014), who conducted a similar study, have stated that with the increase in temperature toward summer months, the transition of the plant from the vegetative to the generative period decreases, and this causes the plants to be short.

Number of leaves

We determined that different planting times and corm sizes did not have a statistically significant ($P > 0.05$) effect on the number of leaves. The greatest number of leaves appeared after the first (April 1) and third plantings (May 1; 8.15 units) and large corms (8.24 units), while the least number of leaves appeared after the second (April 15) and fifth (June 1) plantings (8.00 units) and small corms (8.00 units) (Table 2). Dod et al. (1989) have investigated the effects of different planting times and corm sizes on flower yield in and quality of Gladiolus and observed the greatest number of leaves from large corms, similar to the results of our study.

Number of flower stem

The effect of different planting times and corm sizes on the number of flower stems was statistically insignificant (P > 0.05). The greatest number of flower stems was from the fifth planting (June 1; 1.50 number/plant) and large corms (1.50 number/plant), while the least number of flower stems was from the third planting (May 1; 1.15 number/plant) and small corms (1.12 number/plant) (Table 3).

Table 3. Effect of different planting times and corm sizes on the number of flower stems, stem thickness, and spike length in *Gladiolus*

Planting Time	Number of Flower Stalks			Flower Stem Thickness			Spike Length		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (April 1)	1.30	1.30	1.30	12.19	13.66	12.92^{a}	54.06	58.00	56.03^{a}
2. DZ (April 15)	1.30	1.30	1.30	11.94	13.23	12.59^{a}	53.70	57.66	55.58^{a}
3. DZ (May 1)	1.00	1.30	1.15	12.65	13.25	12.95^{a}	46.50	50.50	48.50^{bc}
4. DZ (May 15)	1.00	1.16	1.30	11.10	12.85	11.98^{bc}	49.00	54.00	51.50^{b}
5. DZ (June 1)	1.00	2.00	1.50	10.56	11.63	11.10^{c}	42.66	49.00	45.83^{c}
Ort	1.12	1.50		11.68	12.92		49.18^{b}	53.79^{a}	

Notes: DZ: Planting time; KY: small corm (10–12 cm); BY: large corm (12–14cm).

Flower stem thickness

We determined that the effect of different planting times on the thickness of the flower stems was statistically significant (P < 0.01), but that the effect of corm size was not (P > 0.05). The maximum stem thickness was observed from the third planting (May 1; 12.95 mm) and large corms (12.92 mm), while the minimum stem thickness was observed from the fifth planting (June 1; 11.10 mm) and small corms (11.68 mm) (Table 3). Gürcan and Türkoğlu (2000) and Wilfret (1980) have reported that a parallel increase in humidity and temperature increases stem thickness; however, in declining relative humidity values, a temperature increase decreases stem thickness.

Spike length

The effect of different planting times and corm sizes on spike length was statistically significant (P < 0.01). The longest spike was from the first planting (April 1; 56.03 cm) and large corms (53.79 cm), while the shortest spike was from the fifth planting (June 1; 45.83 cm) and small corms (49.18 cm) (Table 3). Spike length is an important quality parameter for the Gladiolus plants, and both vegetative development time and corm size affect this parameter. Similar to our study, Saraç et al. (2010) have investigated the effect of eight different planting times (at 20-d intervals) on the spike and plant height of the White Prosperity variety and have reported that the first (April 20) and fifth (July 10) planting times produced the highest values in terms of plant height and spike length.

Number of florets

We observed that the effect of different planting times on the number of florets was statistically significant (P < 0.01), while corm size was not (P > 0.05) (Table 4). The greatest number of florets was from the first (April 1) and second plantings (April 15; 18.50 number/spike) and large corms (17.72 number/spike), while the least number of florets was from the fifth planting (June 1; 16.17 number/spike) and small corms (16.98 number/spike). Suitable temperatures during the development period had positive effects on the number of florets and flowering. Keleş and Türkoğlu (2015), in their study on the effect of four different varieties (Nova Lux, Purple Flora, White Swan, and Red Beauty) and three planting times (May 8, May 23, and June 6) on the number of florets under Siirt ecological conditions, have found that the greatest the number of florets was in Purple Flora planted on June 6 (17.47 number/spike) and Red Beauty planted on May 23 (15.68 number/spike).

Table 4. Effect of different planting times and corm sizes on the number of florets, corm harvest time, and number of new corms in *Gladiolus*

Planting Time	Number of Florets			New Corm Harvest Time			Number of New Corms		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (April 1)	18.00	19.00	18.50[a]	186.00	186.00	186.00	1.06	1.16	1.11
2. DZ (April 15)	18.00	19.00	18.50[a]	171.00	171.00	171.00	1.10	1.00	1.05
3. DZ (May 1)	16.60	16.60	16.60[b]	156.00	156.00	156.00	1.08	1.00	1.04
4. DZ (May 15)	17.00	17.00	17.00[b]	174.00	174.00	174.00	1.16	1.00	1.08
5. DZ (June 1)	15.30	17.00	16.17[b]	158.00	158.00	158.00	1.00	1.00	1.00
Avg.	16.98	17.72		169.00	169.00		1.08	1.03	

Notes: DZ: Planting time; KY: small corm (10–12 cm); BY: large corm (12–14cm).

New corm harvest time

The effect of different planting times and corm sizes on new corm harvest time was statistically insignificant (P > 0.05). While the latest harvest was from the first planting, the third and fifth plantings were harvested earlier, and the second and fourth plantings were harvested at nearly the same time. Large and small corms were harvested at the same time (169 d) (Table 4).

Number of new corms

The effects of different planting times and corm sizes on the number of new corms were not statistically significant (P > 0.05). The maximum number of new corms was from the first planting (April 1; 1.11 numbers/plant) and small corms (1.08 numbers/plant), while the minimum number of new corms was from the fifth planting (June 1; 1.00 numbers/plant) and large corms (1.03 numbers/plant) (Table 4). Dod et al. (1989) have investigated the effects of different planting times and corm sizes in India on flower yield and quality of the Dibonar variety of Gladiolus for corms planted at different times (September 3, September 18, and October 3). Plant height, number of leaves, beginning of flowering, number of florets per spike, spike length, floret diameter, flower length, and the number of cormels per plant have the best results from large corms and early plantings.

Diameter of new corms

The effects of different planting times and corm sizes on the diameter of new corms were insignificant (P > 0.05). The maximum corm diameter was obtained from the third planting (May 1; 5.02 cm) and large corms (4.77 cm), while the minimum corm diameter was obtained from the fifth planting (June 1; 4.09 cm) and small corms (4.55 cm) (Table 5).

New corm circumference and weight

Different planting times (P< 0.01) and corm size (P<0.05) had an impact on the circumference of the new corms in the Red Beauty variety. The maximum corm circumference was from the fourth planting (May 15; 15.92 cm) and large corms (14.54 cm), while the minimum corm circumference was from the third planting (May 1; 11.68 cm) and small corms (13.77 cm), (Table 5). We observed that the effect of different planting times on new corm weight was statistically significant (P < 0.01) but that corm size not (P > 0.05). The maximum new corm weight was from the fourth planting (May 15; 42.17 g) and large corms (32.94 g), while the minimum corm weight was from the third planting (May 1; 22.48 g) and small corms (27.72 g) (Table 5).

Table 5. Effect of different planting times and corm sizes on the diameter of new corms, new corm circumference, and new corm weight in *Gladiolus*

Planting Time	New Corm Diameter			New Corm Circumference			New Corm Weight		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (1 April)	4.21	5.35	4.78	13.56	15.41	14.84[ab]	25.14	30.82	28.46[bc]
2. DZ (15 April)	4.29	4.93	4.61	14.91	14.99	14.95[ab]	28.31	29.35	28.83[b]
3. DZ (1 May)	5.90	4.15	5.02	12.83	10.52	11.68[c]	26.44	18.52	22.48[c]
4. DZ (15 May)	4.71	4.91	4.81	15.53	16.30	15.92[a]	36.63	47.70	42.17[a]
5. DZ (1 June)	3.65	4.53	4.09	12.02	15.52	13.71[b]	22.11	38.34	30.23[b]
Avg.	4.55	4.77		13.77[b]	14.54[a]		27.72	32.94	

Notes: DZ: Planting time; KY: small corm (10–12 cm); BY: large corm (12–14cm).

Number and weight of cormels

The effect of different planting times and corm sizes on the number and weight of the cormels were insignificant (P > 0.05). The greatest number of cormels was observed from the first planting (April 1; 1.46 numbers/plant) and small corms (0.62 numbers/plant), while the least number of cormels was observed from the fifth planting (June 1; 0.10 numbers/plant) and large corms (0.35 numbers/plant) (Table 6).The maximum cormel weight was observed from the first planting (April 1; 37.59 g) and small corms (16.61 g) and the minimum cormel weight was observed from the third planting (May 1; 2.82 g) and large corms (12.80 g) (Table 6). Singh (2000) has investigated the effects of different corm sizes on the development, flowering, and corm yield of Gladiolus using six sizes of Pink Friendship corms (>1.9–2.5 cm and >6.0–6.5 cm) that were planted for 3 years at a planting distance of 30 x 20 cm. The researcher has stated that the cormels obtained from large corms had higher cormel yields per plant than that generated from medium to small corms (Singh, 2000).

Table 6. Effect of different planting times and corm sizes on Gladiolus cormel number, cormel weight, and corm yield

Planting Time	Cormel Number			Cormel Weight			Corm Parcel Yield		
	KY	BY	Avg.	KY	BY	Avg.	KY	BY	Avg.
1. DZ (April 1)	2.37	0.55	1.46	46.53	28.66	37.59	711.50[bcd]	777.20[abcd]	744.30[b]
2. DZ (April 15)	0.24	0.79	0.51	15.60	12.83	14.21	705.00[bcd]	786.00[abcd]	745.50[b]
3. DZ (May 1)	0.28	0.08	0.18	2.60	3.04	2.82	631.70[cde]	361.40[e]	496.50[c]
4. DZ (May 15)	0.14	0.20	0.17	10.66	10.5	10.58	895.40[abc]	1095.00[a]	995.40[a]
5. DZ (June 1)	0.08	0.13	0.10	7.66	9.00	8.33	554 .00[de]	1022.00[ab]	788.10[ab]
Avg.	0.62	0.35		16.61	12.80		690.40	808.20	

Notes: DZ: Planting time; KY: small corm (10–12 cm); BY: large corm (12–14 cm).

Corm parcel yield

The effect of different planting times on corm parcel yield was significant (P < 0.01), and the effect of corm size was insignificant (P > 0.05). We observed that the yield obtained from the early plantings when the temperatures in Şanlıurfa was higher than that from planting times when the temperatures were first low and later high. Accordingly, the maximum corm yield was observed from the fourth planting (May 15; 995.40 g) and large corms (808.20 g), while the minimum corm yield was from the third planting (May 1; 496.50 g) and small corms (690.40 g) (Table 6).

CONCLUSION and RECOMMENDATIONS

In the present study conducted under Şanlıurfa ecological conditions, the effects of different planting times and corm sizes on emergence time, 70% flowering time, plant height, spike length, and new corm circumference were statistically significant. We determined that the effects of different planting times on the first flowering period, the duration of staying in flower, the number of florets, the stem thickness, the new corm weight, and corm yield were also statistically significant, but that the effects of different planting times and corm sizes on the number of flower stalks, the number of leaves, corm harvest time, number of cormels, weight of the cormel, number of new corms, and diameter of the new corm were statistically insignificant. In the light of the above, we suggest that open Gladiolus can be produced in the hot summer months under Şanlıurfa conditions. In addition, by spreading the growing period throughout the year and making additional plantings, especially in winter months during low light intensity and when day length is shortened, Gladiolus can be produced in greenhouses in January, February, and March.

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