

Effects of Corm Size, Planting Time and Pot Size on Plant Development and Flowering of *Gladiolus* × *hybrida*

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Abstract – Experiments based on different corm size, planting time and pot size on *Gladiolus* × *hybrida* cultivar Butterfly were conducted during 2013-2014. These experiments were laid out on completely randomized design with ten replicates. All plant growth and flowering characteristics were significantly ($P \leq 0.05$) affected by different corm size, planting time and pot size. Large sized corms (4 cm) produced maximum plant height, number of leaves per plant, leaf area, number of flowers per spike, flower size, days to flower persistence and spike length whereas days to flowering were decreased. Similarly, gladiolus corms sown in October 1 and 15 more or less behaved alike and performed the best regarding plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length parameters. Results obtained from different pot experiment showed that 30 cm pot size is the most suitable for gladiolus growing. Therefore, 4 cm gladiolus corm size in the month of October using 30 cm pots is recommended for its cultivation under agro-climatic condition of Al-Ahsa, Kingdom of Saudi Arabia.

Keywords – *Gladiolus* × *hybrida*, Corm Size, Planting Time, Pot Size, Plant Development, Flowering.

I. INTRODUCTION

Ornamentals are extensively grown for their cut flower and foliage properties and their trade is a fast growing global industry. According to the Australian Agency for International Development, global consumption of cut flowers has enhanced in recent years, with growth rates of 30% by 2014, which are mainly exported to Europe, Japan and North America. At present, cut flowers world trade estimated as UD\$5.5 billion, nearly 70% of which is within the Europe [1]. The Netherlands is the largest European producer of cut flowers and foliage and plays a vital role in the distribution of flowers around the continent, but its share is diminishing since 2013 as the supply from developing countries is gradually increasing. The main markets in Europe in terms of consumption value per capita are Switzerland, Germany, the UK, the Netherlands and Italy [2].

Among cut flowers, *Gladiolus* spp. is one of the most prominent ornamental plants in the iris family. The splendid inflorescence with florets of stunning colours, diverging forms and sizes and long vase life makes it an eye-catching cut flower. It is an elemental component of most flower arrangements including bouquets. It is commonly propagated by corms, which are varied in size and have great impact on plant growth and flowering spike. An optimum diameter corm is preferred than the smaller ones due to better plant establishment and flower quality [3], [4]. Similarly, the date of planting plays an

essential role in regulating plant growth and quality. Generally gladiolus is grown in the winter, however, in moderate weather conditions, it can be grown round the year except in the summer months. Sowing of corms at suitable time not only regulates steadily supply of the crops to the market but also enhance flower display time in the landscape [5], [6]. Beside its use as cut flower, gladiolus is also grown as boarder or pot plant for outdoor beautification. A considerate attention is needed for the selection of appropriate pot size, which also stimulate quality and performance of transplant. Shoot and root growth, photosynthesis, leaf chlorophyll content, plant water relations, nutrient uptake, respiration, flowering, and yield all are influenced by pot size [7], [8]. Hence, present studies were carried on to figure out a suitable corm size, planting time and pot size for the growth and flowering traits of potted gladiolus under the climatic conditions of Al-Ahsa, Kingdom of Saudi Arabia.

II. MATERIALS AND METHODS

Three experiments on *Gladiolus* × *hybrida* cultivar Butterfly were conducted at Agricultural Research and Veterinary Experimental Station, King Faisal University, Al-Ahsa, Saudi Arabia during 2013-2014. First experiment was conducted during October to determine the effect on different corms sizes (2, 3 and 4 cm), which were planted 10 cm deep in 30 cm pots. Second experiment was done to assess the impact of different planting times (September 1 and 15, October 1 and 15, and November 1 and 15). Third experiment was conducted to evaluate different pot sizes (9.2, 15.2, 20.9, 26 and 30 cm) during October. Corms were planted into pots containing 1:3 mixture of sand and organic compost (Table 1). The experiment was laid out on completely randomized design having ten replications in each treatment. Plants were observed daily and water was applied manually with the help of sprinkler whenever needed. Care was taken not to apply excess water around the root area to minimize any chance of root rot disease. Recommended dose of NPK (10:10:5 g pot⁻¹) was applied to all treatments [9]. Special attention was also given to pot spacing in order to reduce plant competition (shade avoidance). Due to organic nature of soil media weeds were rooted out by hand whenever emerged. The growth and development parameters measured were: plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length. MSTAT-C (Michigan State University, USA) software was used for data analysis and to calculate least significance of differences.

Table 1. Chemical composition of the compost substrate

Organic matter (%)	28.20
pH	7.4
EC (dS cm ⁻¹)	715
Total nitrogen (%)	6.1
Total phosphorus (%)	0.6
Total potassium (%)	1.88

III. RESULTS AND DISCUSSION

Results obtained from experiment 1 indicated a significant ($P \leq 0.05$) difference among means regarding plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length affected by three corm sizes (Table 2). Maximum plant height (81.83 cm), leaf number (7.50), leaf area (301.50 cm²), number of flowers per spike (15), flower size (7 cm), days to flower persistence (18.17) and spike length (35 cm) were observed when 4 cm sized corms were planted. Plants grown from the same corm size produced flowers in minimum time (96.83 days). On the other hand, plants raised from smaller corm size (2 cm) produced minimum plant height (50.50 cm), leaf number (3.33), leaf area (157.50 cm²), number of flowers per spike (7.67), flower size (3.33 cm), days to flower persistence (8.33) and spike length (15.33 cm). The same corm sized plants took long time to flower from emergence (120.33 days). Similarly, results obtained from 3 cm corms size were in between the highest and lowest corm size.

The size of the corm used for planting is very important for the selection of planting materials for best quality gladiolus plants. It is because the corm size influenced both vegetative and reproductive growth. Present study revealed that when the size of the planted corm increased, vegetative growth (plant height, leaf numbers, leaf area and spike length) also increased. The increase in magnitude of these growth characteristics in proportion to the corm size used for planting may be attributed to the amount of assimilates stored in the corm prior to planting, which indicated highest accumulation of carbohydrates [10]. These assimilates were then utilized to produce large sized highest number of flowers in a minimum time. Delay in flowering time, when gladiolus were grown from small corm size might be due to the incompetency of the apex dome to recognize the environmental signal to initiate flowering [11]. Kareem *et al.* [12] observed that large corm size (3-3.5 cm) produced maximum plant height, number of leaves per plant and days required for flowers, number of florets per spike and intact flower life in cultivars Red Majesty and Early Yellow. Similarly, Uddin *et al.* [3] obtained highest plant height, number of leaves per plant, days to flower initiation and length of flower stalk by planting large sized corms. McKay *et al.* [23] reported that flowering, branching and flower yield were increased by the large corms. Plant height, number of leaves per plant, time to flowering and spike length were significantly improved by increasing size of corm size [24]. Reduced flower blooming time and increased plant height, No. of florets per spike and flower size was

observed in ten gladiolus cultivars when > 5 to < 6 cm corms were planted [25].

Table 3 indicated a significant ($P \leq 0.05$) difference among means regarding plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length affected by six planting times. Maximum plant height (90.67 cm), leaf number (7.67) and leaf area (257.50 cm²) was recorded when gladiolus corm were sown on September 1, closely followed by September 15 planting date. However, maximum number of flowers per spike (14.50), flower size (7.33 cm), days to flower persistence (19.67) and spike length (36.33 cm) were observed when corms were sown on October 15, closely followed by October 1 sowing date. Corms planted on October 1 took minimum days to flower (91.50). Both planting dates (October 1 and 15) were statistically at par. Corms planted in November produced minimum plant height (73.33 cm), leaf number (6.33), leaf area (168.50 cm²) whereas minimum number of flower per spike (8.67), flower size (3.83), days to flower persistence (10.67) and spike length (19.50 cm) were recorded when corm were sown in the month of September. Plants raised from the early sowing dates (September 1 and 15) flowered late (116.33 and 118.67 days, respectively) as compared to late sowings.

Initial growth of gladiolus was accelerated by high early two months mean diurnal temperature (30.75°C) received by corms planted in September. High temperature enhanced vegetative developmental phase and in response plant height, leaf numbers, leaf area and stalk length was increased. A linear decreased in mean diurnal temperature in October (25.25°C) and November (19.75°C) sowing dates significantly decreased these vegetative growth traits. These findings suggest that high optimal temperature during September encouraged photosynthetic functions through active carbohydrates metabolism, which results in rapid plant organ formation [13]. Similar findings were observed by Adil *et al.* [14] when gladiolus cultivars Rose Supreme and White Prosperity were planted in September. Islam and Haque [15] also reported similar results when plant height, leaf numbers and spike length decreased linearly with the late sowing time. On the other side, plant reproductive phase was delayed by the early sowing date than the late ones. Plants took minimum time to flower when corms were sown in October followed by November sowing. Flower induction is believed to be a function of temperature, photoperiod and/or gibberellin [16]. Present results indicated that time to flowering was decreased when mean diurnal temperature was decreased from 22.50°C (September planting) to 15.75°C during flower induction time i.e. December to February in case of late sowing dates (October and November). It indicated that gladiolus floral genes might response to low temperature or vernalization. Therefore, future investigation should be focused on to these factors under controlled environment. Moreover, flower display time of various herbaceous ornamentals was also extended by sowing them at different time for their consistent supply to the market [17], [6]. In present study, gladiolus cultivar

Butterfly grown at different time produced flowers up to three months from first bloom (December to February), which showed its potential for steady market supply. Working on Tuberose, Asif *et al.* [26] obtained best results regarding sprouting of corms, number of leaves, plant height, number and length of spike, number of florets, flower quality and number of corms per plant when sown in March at 12.37-27.50°C mean minimum and maximum temperatures respectively.

Plant grown in different pot size significant ($P \leq 0.05$) affect plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length (Table 4). Maximum plant height (90.67 cm), leaf number (8.50), leaf area (300.17 cm²), number of flowers per spike (16), flower size (7.17 cm), days to flower persistence (18.83) and spike length (36.17 cm) were recorded when plants were grown in 30 cm pots. Plants in the same pot size flowered in minimum time to flower (92.33 days). Similarly, plants grown in 26 cm pots behaved more or less similar to 30 cm pot sized plants. Plants grown in smallest sized pots (9.2 cm) produced minimum plant height (53.83 cm), leaf number (3.17), leaf area (161.67 cm²), number of flowers per spike (7.50), flower size (3.3 cm), days to flower persistence (9.83) and spike length (15.33 cm) and took maximum days to flower (122.17).

It is well-documented that the growth rates of shoots and roots are co-dependent [18], therefore, plants grown in optimum sized pots positively influenced plant growth including leaf area, shoot and root biomass [19]. Roots depend on plant aerial parts such as stem, leaves, branches for assimilates and various growth hormones, whereas the aerial parts rely on the under-ground part (roots) for water, nutrients, support, and hormones [7]. A slight imbalance between roots and shoots interaction can affect plant growth when the root system is restricted. Results observed in present study revealed a strong influence of 30 cm pot size on plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length. Gladiolus plants grown in large sized pot (having maximum soil volume) developed very effectual root system hence produced taller plants with maximum leaf numbers, leaf area, number of flower and spike length, which eventually decreased days taken to flower and increase flower longevity. These characteristics were affected negatively as the pot size decreased. The reason could be when roots growth is confined, they compete for essential resources, increased root mass and decreased rooting space that leads to competition for available oxygen [20]. Moreover, as pot size is decreased the amount of soil media pore space decreases, reducing both water holding capacity and soil aeration [21]. Similarly, plant height and biomass reduction in small pots have been reported for marigold [22]. Field plant distance of gladiolus corms 30 × 40 cm and 40 × 40 cm were found at par regarding plant height, spike length, number of florets per spike parameters [24].

VI. CONCLUSION

Findings of present study showed that different corm size, planting time and pot size significantly affect plant height, number of leaves per plant, leaf area, days to flowering, number of flowers per spike, flower size, days to flower persistence and spike length. It is therefore, concluded that the best corm size is 4 cm, which should be planted in the month of October in 30 cm pots to obtain optimum growth and development characteristics including an early flowering of gladiolus plants under ecological conditions of Al-Ahsa.

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Table 2. Effect of different corm size on growth and flowering characteristics of Gladiolus × hybrid cv. Butterfly.

Corm size	Plant height (cm)	Leaf number	Leaf area (cm ²)	Daysto flowering	Flowers per spike	Flower size (cm)	Days to flower persistence	Spike length (cm)
2 cm	50.50±4.64	3.33±0.33	157.50±8.73	120.33±1.67	7.67±0.42	3.33±0.42	8.33±0.71	15.33±1.31
3 cm	66.33±3.80	5.00±0.58	232.50±17.30	104.33±1.87	11.67±0.99	4.17±0.54	16.50±1.06	28.67±2.01
4 cm	81.83±2.60	7.50±0.88	301.50±20.68	96.83±3.24	15.00±0.37	7.00±0.68	18.17±1.01	35.00±2.56
Probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.004	<0.001	<0.001
SED _(0.05)	4.96	0.772	22.65	3.54	0.807	0.863	1.006	2.65
LSD _(0.05)	11.05	1.721	50.47	7.88	1.799	1.922	2.24	5.91

± indicated standard errors within replicates.

SED indicated standard error of difference among means.

LSD indicated least significant difference among means.

Probability indicated the level of significance.

Table 3. Effect of different planting time on growth and flowering characteristics of Gladiolus × hybrid cv. Butterfly.

Planting time	Plant height (cm)	Leaf number	Leaf area (cm ²)	Days to flowering	Flowers per spike	Flower size (cm)	Days to flower persistence	Spike length (cm)
September 1	90.67±2.94	7.67±0.42	257.50±15.58	116.33±3.48	8.67±0.71	3.83±0.60	10.83±1.25	31.17±2.23
September 15	85.17±4.21	7.17±0.60	2.33.33±8.91	118.67±3.13	9.50±0.88	4.00±0.58	10.67±1.94	31.00±2.94
October 1	79.67±3.22	6.33±0.88	205.00±10.33	91.50±4.15	14.17±1.40	7.00±0.58	17.67±1.38	36.17±2.53
October 15	76.67±2.65	6.50±0.76	196.67±5.11	94.33±6.39	14.50±1.77	7.33±0.61	19.67±1.05	36.33±1.61
November 1	73.33±1.54	6.33±0.88	174.17±11.72	107.67±2.04	12.33±1.52	6.33±0.49	14.67±1.17	20.33±1.65
November 15	75.00±1.71	6.50±0.76	168.50±5.77	106.17±2.24	11.67±0.99	6.67±0.61	15.67±0.88	19.50±1.87
Probability	<0.001	0.640	<0.001	<0.001	0.007	<0.004	<0.001	<0.001
SED _(0.05)	3.65	0.933	14.41	5.65	1.663	0.786	1.608	2.222
LSD _(0.05)	7.52	1.921	29.68	11.64	3.425	1.619	3.313	4.576

± indicated standard errors within replicates.

SED indicated standard error of difference among means.

LSD indicated least significant difference among means.

Probability indicated the level of significance.

Table 4. Effect of different pot size on growth and flowering characteristics of Gladiolus × hybrid cv. Butterfly.

Pot size	Plant height (cm)	Leaf number	Leaf area (cm ²)	Days to flowering	Flowers per spike	Flower size (cm)	Days to flower persistence	Spike length (cm)
9.2 cm	53.83±4.48	3.17±0.40	161.67±7.71	122.17±1.70	7.50±0.72	3.33±0.56	9.83±1.56	15.33±1.31
15.2 cm	65.00±4.08	5.33±0.84	202.50±17.01	111.83±4.09	9.67±0.76	4.50±0.81	12.83±1.08	20.33±1.65
20.9 cm	78.83±4.58	5.67±0.88	231.33±8.80	106.00±3.47	11.50±1.09	5.33±0.61	15.00±1.13	25.00±2.80
26 cm	91.33±4.70	7.33±0.56	262.50±24.24	95.17±4.22	14.17±0.91	6.83±0.75	17.00±1.24	31.67±2.51
30 cm	90.67±2.94	8.50±0.43	300.17±27.69	92.33±3.76	16.00±1.73	7.17±0.65	18.83±0.83	36.17±0.79
Probability	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
SED _(0.05)	5.43	0.966	28.28	5.22	1.448	0.872	1.429	2.901
LSD _(0.05)	11.33	2.014	58.99	10.89	3.02	1.82	2.982	6.051

± indicated standard errors within replicates.

SED indicated standard error of difference among means.

LSD indicated least significant difference among means.

Probability indicated the level of significance.