Pak. J. Bot., 55(5): 1789-1794, 2023. DOI: http://dx.doi.org/10.30848/PJB2023-5(22)

CLIMATIC ADAPTABILITY OF EXOTIC *GLADIOLUS GRANDIFLORUS* VARIETIES UNDER THE ENVIRONMENT OF LAHORE, PAKISTAN

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Abstract

Gladiolus grandiflorus Andrews is among the most popular cut flowers. In the present study, the effect of sowing time on growth, flowering, and corm characteristics of six newly introduced varieties of this cut flower in Pakistan, namely Red Balance, Cartago, Beach Party, Cayenne, Kir Royal, and Almerium, was studied under agro-ecological conditions of Lahore, Pakistan. Corms of these varieties were sown in a field on November 30, December 15 and 31, 2019, with average temperatures of 16, 14, and 12ºC, respectively. Sowing dates had significant effects on various vegetative and reproductive characteristics. In general, maximum plant height, leaf width, minimum days to flowering, number of florets per plant, and floret diameter were recorded in plants sown on November 30 (and sometimes on December 15 also), while the lowest values for all these parameters were obtained in plants sown on December 31. The number of cormels were gradually decreased in Beach Party, Cayenne, Kir Royal, and Almerium with the delay of sowing from November 30 to December 15 and 31. On the other hand, in Red Balance, Cartago, the highest number of cormels was recorded on December 31 owing plants. This study concludes that cultivation on November 30 is the most suitable time for most of the gladiolus varieties for the best vegetative and reproductive growth in agro ecological zone of Lahore.

Key words: Climatic adaptability, Floral characteristics, *Gladiolus* germplasm, Lahore, Punjab, Sowing dates.

Introduction

Gladiolus (*Gladiolus grandiflorus*) is an important ornamental plant commonly known as Sword Lily (Nag and Kumar, 2021). It belongs to Iridaceae family which has more than 2,000 known species (Xu and Chang, 2017). *Gladiolus grandiflorus* is grown in various parts of Pakistan, where it profusely blossoms during spring and summer (Riaz *et al*., 2010; Nasar *et al*., 2018). The plant is used commercially as a cut flower and infrequently for landscape purposes. It is gaining popularity because of its diverse range of colors and shapes, broad adaptability to different regions, and acceptable vase life (Riaz *et al*., 2009; Azimi, 2019). It is amongst the few flowers which produce very attractive cut flowers with long spikes. In recent years, its production has increased in Pakistan due to increased demand for flowers used in bouquets and garlands, and for decoration at weddings and social events (Khan *et al*., 2017). To fulfill consumers' demand, it is imperative that the flowers are available around the year (Riaz *et al*., 2007).

Planting time and climatic conditions play a key role in regulating the quality and yield of cut flower production (Nafees *et al*., 2021). Previously, *Gladiolus* species were planted at different times, producing the highest number of corms from March and April plantings in several varieties. In comparison, maximum spikes were obtained from April plantings (Ahmad *et al*., 2011). Late plantings resulted in early flowering with low-quality stems and reduced yield in comparison to those cultivated earlier in the season. Although it took a long time to start flowering, early sowing produced good quality stems (Becker *et al*., 2019). The plantings in the months of February and March produced a better gladiolus corm size (Khutiya *et al*., 2018). Like other plants, the growth and yield of *Gladiolus* are dependent upon light intensity, temperatures, and photoperiod (Shaukat *et al*., 2013). Different gladiolus varieties were planted in late summer or early winter, where these produced a higher number of corms, florets per spike, spike length, plant height, and better vase life (Kumari *et al*., 2011; Dhatt & Jhanji, 2021). Therefore, to meet consumers' demand, *Gladiolus* vegetative growth and flower quality can be improved by suitable planting times (Maurya *et al*., 2013). Since sowing time has a marked effect on the quantity and quality of flowers, the present study was undertaken to explore a correct planting date for six newly introduced varieties of *G. grandiflorus viz.*, Red Balance, Cartago, Beach Party, Cayenne, Kir Royal, and Almerium, under agro-climatic conditions of Lahore, Pakistan, so that the more attractive floral stalks can be obtained to meet the demand of the consumers.

Materials and Methods

Characteristics of the study site: Lahore is situated between 31°15′–31°45′ N and 74°01′–74°39′ E, and 214 meters above sea level. The climate of Lahore is semi-arid, with an average rainfall of 628.8 mm per annum. June is the hottest month, where the temperature may generally exceed 45ºC. During the months of July and August, humidity is at its peak due to extensive monsoon rains with the possibility of floods. The month of January is the coolest, with extremely dense smog (smoke + fog). Experiments were conducted on November 30, December 15, and 31 with an average temperature range of 16ºC, 14ºC, and 12ºC, respectively.

Procurement of gladiolus varieties: Six new varieties of *Gladiolus*, namely Red Balance, Cartago, Beach Party, Cayenne, Kir Royal, and Almerium, were imported through Lahore-based company Green Works Pvt. Ltd. Lahore from Holland to be used in the reported field trial.

Field trial: A field experiment was carried out during 2019-20 at research fields in the Faculty of Agricultural Sciences, University of the Punjab Lahore, Pakistan. The soil was sandy loam with a pH of 7.5 and organic matter of 0.72%. The trial area was well ploughed, and ridges were prepared. The trial was conducted by using a randomized complete block design (RCBD) with three replications. The sowing of corms was done on ridges by keeping a 150 cm distance from row to row at three different sowing dates, *viz.*, November 30, December 15, and December 31.Tunicated skin of corms was removed, and the corms were sown at a depth of 5 cm on the sides of ridges. Field plots were irrigated just after sowing. A basal dose of NPK was applied @ 100 kg per acre at the time of soil preparation. The second dose of urea was applied by using the top dressing method at the third leaf stage of plants and the third one at the sixth leaf stage. Hoeing was done to clear the weeds of the experimental area. The field plots were irrigated periodically according to requirement until the accomplishment of the trial.

Harvesting and data collection: Three randomly selected plants from each replicate were selected for the tabulation of data to different parameters. The length and width of the third leaf and the total number of leaves per plant for each replicate were recorded at the blooming stage. The number of days taken from the time of sowing to flower initiation was recorded, and data regarding flowers diameter and the number of flowers per plant were also taken. The floral stem was dried after removing the flowers and weighed. A digital type of Vernier caliper was used to measure the flower diameter. When the leaves became pale yellow, the bulbs and cormels were harvested and counted.

Statistical analysis: Standard errors of means of three replicates were calculated for all the studied vegetative and reproductive parameters. Two-way ANOVA analyzed all the data, and the means were separated by applying the LSD test at $p \leq 0.05$ using the software Statistix 8.1.

Results and Discussion

Effect of sowing time on vegetative growth: ANOVA presented in Table 1 indicates that the effect of sowing dates (S), gladiolus varieties (V), and their interaction (S × V) was significant ($p \leq 0.001$) for plant height. Likewise, the effect of S was significant ($p \leq 0.001$) for leaf width, while that of V was significant for the number of leaves ($p \leq 0.001$) and leaf length ($p \leq 0.01$).

In all the six tested Gladiolus varieties except Cayenne, there was not any significant difference in plant height between the first two sowing dates, i.e., November 30 and December 15. However, late sowing on December 31 significantly reduced plant heights by 23–37% in different varieties as compared to plant height in plants sown on November 30 (Fig. 1A). It indicates that temperature during the early days of sowing is critical for the proper growth of Gladiolus. Although there was not too much difference in temperature among the planting dates (a difference of 2ºC between the two successive planting dates), however, there was a much lower temperature in the month of January (min. 2–11ºC, max. 10–21ºC) due to which December 31 sowing plants could not attain as much height as was attained in plants sown on November 30 and December 15. Adil *et al*., (2013) reported a positive correlation between temperature and plant height for Gladiolus var. Indian Local. Gursan (1990) reported that the gladiolus plants attained a height of 113 cm under warm temperatures than 77 cm in plants sown under lower temperatures. The better height in early sowing plants could be due to favorable temperatures that might have supported more nutrient uptake and more accumulation of photosynthates (Bose & Tripathi, 1996; Srinivas *et al*., 2017).

There was a significant difference in the number of leaves among the varieties. The highest number of leaves per plant was recorded in Kir Royal, followed by Cartago. However, all the varieties were irresponsive to sowing time with respect to the number of leaves (Fig. 1B). Likewise, the effect of sowing time on leaf length was also insignificant in all the varieties except Cayenne, where sowing on December 31 significantly reduced leaf length as compared to the two early sowing dates (Fig. 1C). By contrast, sowing time had a significant effect on leaf width in most of the test gladiolus varieties. In Red Balance, Beach Party, Cayenne, and Almerium, leaf width was significantly reduced in December 31 sowing plants as compared to November 30 sowing plants (Fig. 1D). These results contradict the findings of most previous studies where the number of leaves, leaf length, and leaf width were significantly influenced by sowing time (Ahmad *et al*., 2011; Adil *et al*., 2013; Srinivas *et al*., 2017).

Effect of sowing time on flowering: The effect of S, V, and S × V was significant for days to flowering, number of florets per spike, floret diameter, and dry weight of spike or floral stem (Table 1). The minimum number of days taken to initiate flowering was generally taken in plants sown on November 30. Delayed sowing on December 31 significantly increased the number of days to flowering. In plants sown on November 30, it took 87 to 90 days to start flowering in different varieties. On the other hand, flowering was started after 92 to 101 days in plants sown on December 31 (Fig. 2A). Srinivas *et al*., (2017) reported that it took 59.6 days to initiate the spikes in Gladiolus var. American Beauty when corms were sown on October 1 as compared to 67.2 days on August 15 sowing plants. Similarly, this variety took a minimum number of days (105.5) to start the formation of spikes when sown on October 15, and the maximum number of days (114.5) due to late sowing on December 15 in Hisar, India (Singh *et al*., 2019). Suitable temperature and light duration play important roles in initiating the floral spike (Adil *et al*., 2013; Singh *et al*., 2019).

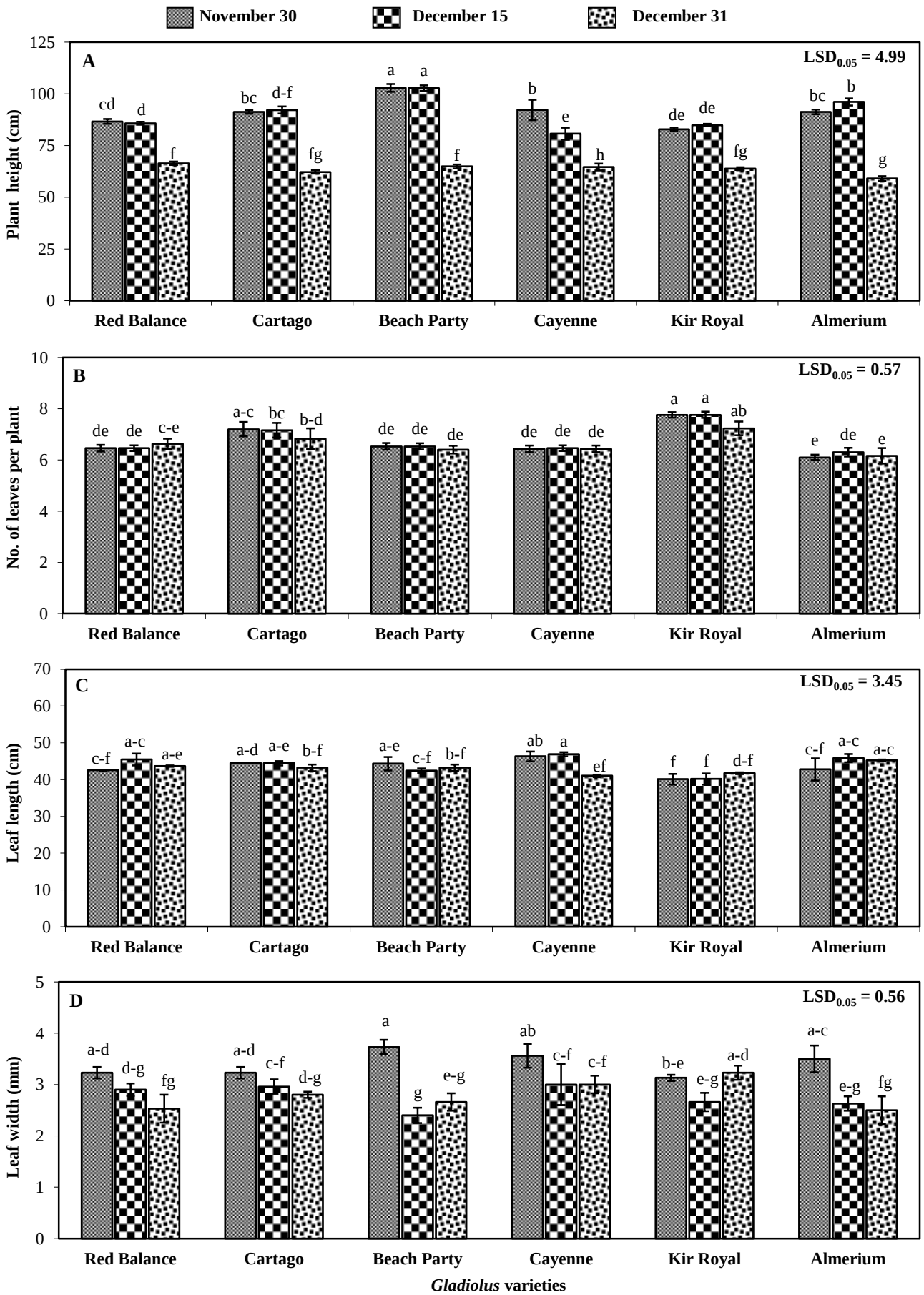

Fig. 1. Effect of sowing time on vegetative growth of *Gladiolus grandiflorus* varieties Red Balance, Cartago, Beach Party, Cayenne, Kir Royal and Almerium. Vertical bars show standard errors of means of five replicates. Values with different letters at their top show significant difference ($p \leq 0.05$) as determined by LSD Test.

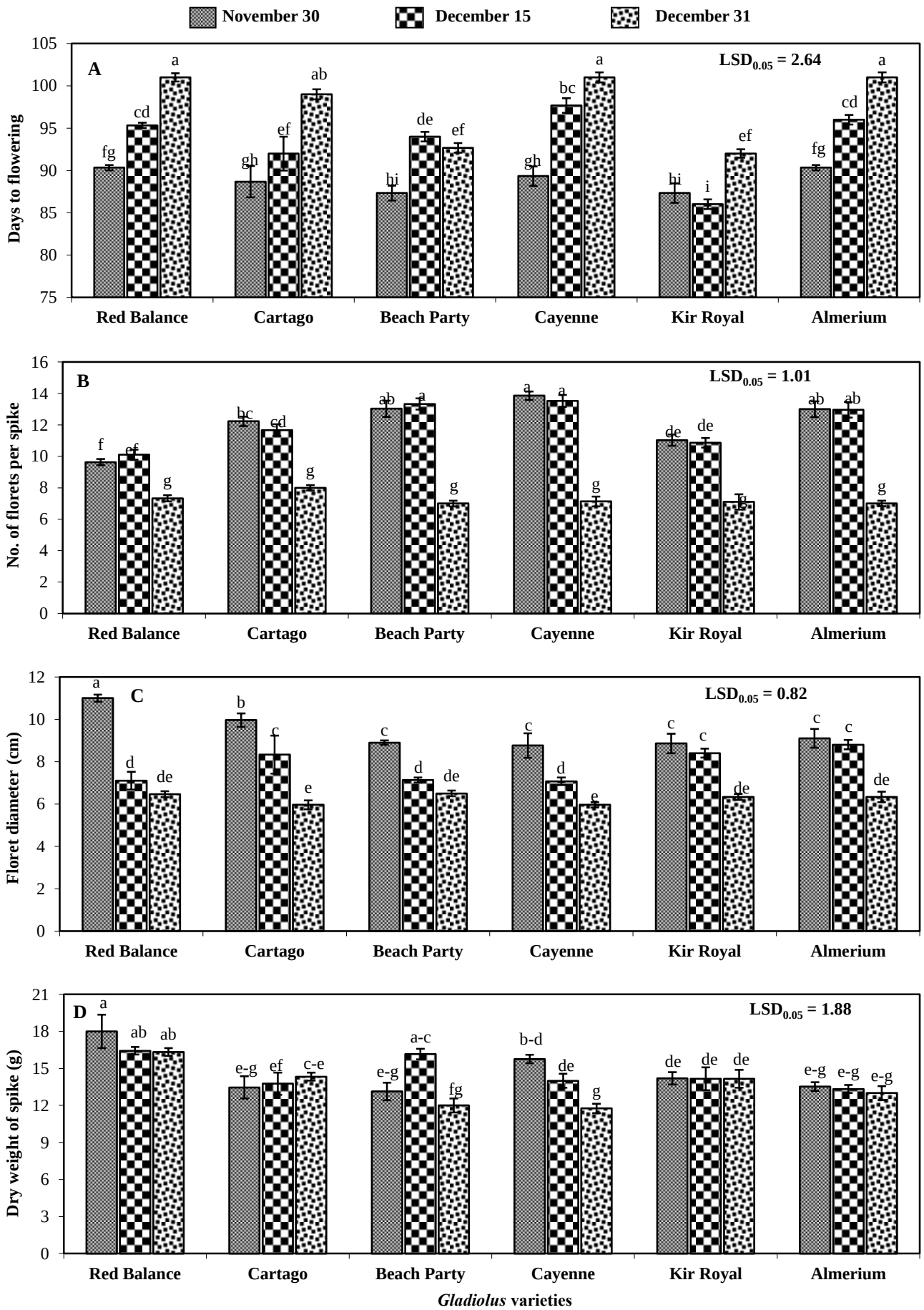

Fig. 2. Effect of sowing time on floral parameters of *Gladiolus grandiflorus* varieties Red Balance, Cartago, Beach Party, Cayenne, Kir Royal and Almerium.

Table 1. Analysis of variance (ANOVA) for the effect of different sowing dates on vegetative and reporductive characteristics of some new varieties of *Gladiolus grandiflorus*.

Sources of variation	df	Mean squares								
		Plant height	No. of leaves	Leaf length	Leaf width	Days to flowering	No. of florets	Floret diameter	Dry weight of spike	No. of cormelss
Sowing dates (S)	2	4481^{***}	0.14^{ns}	6.7^{ns}	2.3^{***}	356^{***}	141^{***}	45.3^{***}	6.8^{***}	200^{***}
Varieties (V)	5	186^{***}	2.39^{***}	20.3^{**}	0.11^{ns}	83^{***}	8.2^{***}	1.22^{***}	15.5^{***}	345^{***}
S × V	10	86^{***}	0.07^{ns}	9.2^{*}	0.22^{ns}	15^{***}	2.8^{***}	1.58^{***}	4.5^{**}	207^{***}
Error	36	9.1	0.12	4.4	0.11	2.55	0.37	0.25	1.28	8.96
Total	53									

*, **, ***, Significant at $p \leq 0.05$, 0.01 and 0.001, respectively

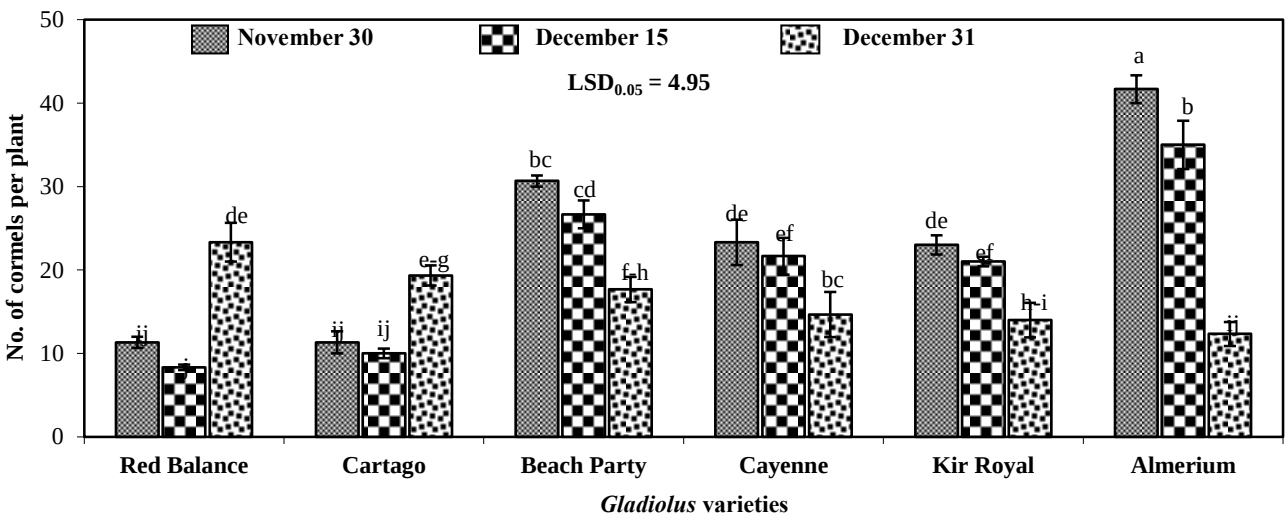

Fig. 3. Effect of sowing time on number of corms of *Gladiolus grandiflorus* varieties Red Balance, Cartago, Beach Party, Cayenne, Kir Royal and Almerium.

There was a marked difference in the number of florets per spike in different varieties. There was no significant difference in the number of flowers between November 30 and December 15 sowing plants in all the six varieties. However, late planting on December 31 significantly reduced the number of florets per spike in different varieties. There were 10 to 13 florets per spike in November 30 sowing plants compared to 7 to 8 in December 31 sowing plants (Fig. 2B). The maximum diameter of florets was recorded on November 30, sowing plants in all the varieties that were gradually reduced by gradual delay in sowing time (Fig. 2C). Maurya *et al*., (2017) found that Gladiolus var. Aldebaran sown on November 15 exhibited better floral characteristics than sowing either earlier or after this date in Lucknow, India.

Spike dry weight showed a variable response to sowing time in different varieties. In Cayenne, there was a gradual decrease in dry weight as the sowing was delayed from November 30 to December 15 and 31. In Beach Party, the highest dry biomass was obtained in plants sown on December 15. In the other four varieties, sowing time had an insignificant effect on the dry biomass of the spike (Fig. 2D).

Effect of sowing time on the number of cormels: The effect of S, V, and S × V was significant ($p \leq 0.001$) for the number of cormels per plant (Table 1). There was much variation in the number of cormels among the varieties. Almerium showed the highest number of cormels, followed by Beach Party. In four varieties, namely Beach Party, Cayenne, Kir Royal, and Almerium, there was a gradual decrease in the number of cormels with gradual delay in sowing. The highest number of cormels was obtained on November 30, sowing plants that were significantly ($p \leq 0.05$) greater than the number of cormels in plants sowing on December 31. By contrast, in Red Balance and Cartago, the highest number of cormels per plant was recorded in plant sowing on December 31 (Fig. 3). Previous studies carried out in Peshawar and Faisalabad showed differences in the number, size, and weight of cormels when other gladiolus varieties were sown at different sowing dates (Ahmad *et al*., 2011; Adil *et al*., 2013). Earlier studies had shown that cormel production was high when gladiolus cultivation was done at slightly higher temperatures, possibly due to the manufacturing of more photosynthates (Parker & Borthwick, 1980). For example, Laskar & Jana (1994) observed that the corms production was better in plants cultivated on March 19 than in plants cultivated on February 7 and 27. Likewise, Ahmad *et al*., (2011) noted that cormel production in gladiolus var. White Friendship was significantly higher in April sowing plants than those sown in February or March when the temperatures were lower in Peshawar. However, the present study indicates that it is not always like this but may vary in different varieties, as Red Balance and Cartago showed the best cormel production on December 31, sowing plants when the temperature was comparatively low. Fatihullah &

Bostan (2018) findings also supported our results, who recorded the maximum number of corm weight and the number of cormel in gladiolus var. Indian Local plants are sown on February 10 than those sown on March 12.

Conclusion

This study concludes that larger floral spikes with a higher number of florets as well as with larger florets in the six studied *G. grandiflorus* varieties can be obtained by planting them on November 30.

References

Adil, M., W. Ahmad, K.S. Ahmad, J. Shafi, M.A. Shehzad, M.A. Sarwar, M. Salman, M.I. Ghani and M. Iqabal. 2013. Effect of different planting dates on growth and development of *Gladiolus grandiflorus* under the ecological conditions of Faisalabad, Pakistan. *Uni. J. Agric. Res.*, 1(3): 110-117.

Ahmad, I., A.M. Khattak, N. Ara and Noor ul Amin. 2011. Effect of planting dates on the growth of gladiolus corms in Peshawar. *Sarhad J. Agric.*, 27: 195-199.

Azimi, M.H. 2019. Progeny test of crosses among different cultivars of Gladiolus. *J. Plant Prod.*, 41: 29-44.

Becker, C.C., N.A. Streck, L.O. Uhlmann and W.B. Silveira. 2019. Scheduling optimum planting window for gladiola based on El Niño Southern Oscillation. *Sci. Agric.*, 77: e20180336.

Bose, U.S. and S.K. Tripathi. 1996. Effect of micronutrients on growth, yield and quality of tomato cv. Pusa Ruby. *Plant Sci. Feed*, 12: 61-64.

Dhatt, K.K. and S. Jhanji. 2021. Evaluating gladiolus varieties for off-season planting using agro-meteorological indices. *J. Agrometeorol.*, 23: 46-53.

Fatihullah and N. Bostan. 2018. Effect of different planting dates on gladiolus production. *Int. J. Environ. Sci. Nat. Resour.*, 9: 555753.

Gursan, K. 1990. Growing *Gladiolus*, Atatürk Horticultural Research Institute1, Yalova.

Khan, M.T.I., Q. Ali and S. Taj. 2017. Estimation of marketing efficiency and price spread of Gladiolus in Punjab, Pakistan. *J. Appl. Environ. Biol. Sci.*, 7: 58-66.

Khutiya, K., Y.C. Gupta, S.R. Dhiman and P. Sharma. 2018. Effect of planting dates on growth, flowering and multiplication of Gladiolus (*Gladiolus grandiflorus*) cv. 'Solan Mangla'. *Curr. Hort.*, 6: 58-63.

Kumari, S., B.S. Patel and L.N. Mahawer. 2011. Influence of gibberellic acid and planting dates on vegetative growth and flower production in gladiolus cv. Yellow Frilled. *Prog. Hort.*, 43: 219-224.

Laskar, M.A. and B.K. Jana. 1994. Effect of planting time and size of corms on plant growth, flowering and corm production of Gladiolus. *Ind. Agric.*, 38(2): 89-97.

Maurya, A.K., S. Maji and S. Kumar. 2013. Effect of planting time and spacing on growth, flowering and spike yield of Gladiolus. In IV International Conference on Landscape and Urban Horticulture, pp. 93-98.

Maurya, A.K., S. Maji and S. Kumar. 2017. Effect of planting time and spacing on growth, flowering and spike yield of Gladiolus. *Acta Hort.*, 1181: 93-98.

Nafees, M., I. Ahmad, R. Qureshi, I. Ashraf, A. Maqsood, M.N. Aslam and M. Noor-un-Nisa. 2021. Performance evaluation of gladiolus cultivars under arid climate of Bahawalpur. *Pak. J. Bot.*, 53: 559-566.

Nag, K. and J. Kumar. 2021. Influence of GA3 and spacing on spike per plant of Gladiolus (*Gladiolus grandifloras* L.). *J. Pharm. Innov.*, 10: 660-661.

Nasar, I.A. and M. Qasim. 2018. Optimizing planting time for some selected commercial gladiolus cultivars under agro-climatic conditions of Faisalabad, Pakistan. *J. Hort. Sci. Technol.*, 1: 21-27.

Parker, M.W. and H.A. Borthwick. 1980. Day-length proved vital factor in gladiolus flowering. *Florists Exch.*, 117: 38-40.

Riaz, T., S.N. Khan and A. Javaid. 2007. Scenario of gladiolus production in Punjab, Pakistan. *Pak. J. Bot.*, 39: 2389-2393.

Riaz, T., S.N. Khan and A. Javaid. 2009. Effect of co-cultivation and crop rotation on corm rot disease of *Gladiolus. Sci. Hort.*, 121(2): 218-222.

Riaz, T., S.N. Khan and A. Javaid. 2010. Screening of *Gladiolus* germplasm for agronomic performance and resistance against corm rot disease. *Afr. J. Biotechnol.*, 9(40): 6701-6707.

Shaukat, S., S. Syed and S. Shoukat. 2013. Performance of Gladiolus (*Gladiolus grandiflora* L.) cultivars under the climatic conditions of Bagh Azad Jammu and Kashmir Pakistan. *J. Cent. Eur. Agric.*, 14: 158-167.

Singh, S., S.K. Sehrawat and S. Sharma. 2019. Effect of planting time and growing conditions on sprouting and growth of *Gladiolus* var. American Beauty. *Int. J. Curr. Microbiol. Appl. Sci.*, 8: 656-662.

Srinivas, D.K., B Vimala, T. Himabindu and G.C. Mouli. 2017. Study on the effect of dates of sowing on growth, flowering and spike yield of gladiolus cultivar American Beauty under different field conditions. *Bull. Environ. Pharmacol. Life Sci.*, 6: 17-28.

Xu, Z. and L. Chang. 2017. Iridaceae. In Identification and Control of Common Weeds: Volume 3. Springer, Singapore. pp. 905-908.

(Received for publication 11 January 2022)