



Influence of Corm Size and Spacing on the Growth, Flowering and Corm Traits of *Gladiolus* cv. Malaviya Shatabdi

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Present study was conducted at the Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the 2023-24 cropping season to evaluate the effects of corm size and spacing on the growth, flowering and corm yield of *gladiolus* cv. Malaviya Shatabdi. The experiment was laid out in a Factorial Randomized Block Design comprising 24 treatment combinations with 3 replications, involving four corm sizes (1.0-2.0 cm, 2.1-3.0 cm, 3.1-4.0 cm and 4.1-5.0 cm) and six spacing treatments (30 cm × 20 cm, 30 cm × 25 cm, 30 cm × 30 cm, 30 cm × 40 cm, 20 cm × 20 cm and 20 cm × 30 cm). The results showed that both corm size and spacing had a significant impact on all growth and yield parameters. The largest corm size (4.1-5.0 cm) led to maximum number of leaves per hill (14.95), highest scape width (2.58

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cm), widest leaves (2.44 cm), longest rachis and intermodal length (44.51 cm and 4.31 cm), highest corm weight (32.39 g) and the highest number of cormels per plant (11.12). Among the spacing treatments, wider spacing (30 cm × 30 cm) resulted in the widest leaves (2.64 cm), more number of leaves (15.05), widest scape (2.81 cm), highest length and width of 3rd (10.03 cm and 8.98 cm) and 5th florets (10.03 cm and 9.03 cm) respectively. The combination of the largest corm (4.1-5.0 cm) and wider spacing (30 cm × 30 cm) produced maximum number of leaves per hill (53.96 cm), maximum number of opened florets (9.91) and the highest number of cormels per plant (13.32). The smallest corm size (1.0-2.0 cm) with closer spacing (20 × 30 cm) resulted in delayed opening of 3rd (102.98 days) and 5th (104.99 days) and the lowest no. of leaves per hill (6.41). These findings suggest that larger corms and wider spacing optimize growth and yield parameters of gladiolus cv. Malaviya Shatabdi.

Keywords: *Gladiolus*; corm grade; spacing; interaction; growth.

1. INTRODUCTION

Gladiolus (*Gladiolus hybrida*), often referred to as "Sword Lily," is a herbaceous annual flowering plant native to South Africa. It is a member of the Iridaceae family, which consists of approximately 260 species (Singh & Sisodia, 2017). This ornamental plant, which produces corms, is mainly cultivated for its cut flowers, though it is sometimes used in landscaping as well (Mukhopadhyay, 1995). *Gladiolus* flowers are known for their striking beauty and are in high demand among consumers. To meet this demand, it is essential to ensure a year-round supply of *gladiolus* flowers (Sharma & Gupta, 2003). As one of the few plants that yield long spikes of attractive cut flowers, *gladiolus* plays an important role in many floral arrangements, ranging from table centerpieces to large bouquets. It takes about two to three growing seasons for cormels to develop into standard flower spikes and daughter corms. However, the commercial production of corms and cormels often falls short of meeting local demand for planting material, resulting in increased corm prices (Arora & Khanna, 1990; Bijimol & Singh, 2001). Several factors, including corm size, spacing, planting depth, timing and fertilizer management, influence the production and quality of *gladiolus* flowers (Anwar & Maurya, 2005; Uddin et al., 2002). Among these, corm size and spacing are particularly significant. Larger corms tend to produce more flowers, corms and cormels compared to smaller ones (Hatibarua & Paswan, 2001; Kumar & Singh, 1998). To ensure optimal spike production, it is crucial to standardize advanced crop management practices tailored to each cultivation area (Bhat et al., 2008). Beyond climatic conditions, plant spacing plays a vital role in achieving higher yields of superior-quality spikes and corms (Kumar & Yadav, 2006). For

large-scale commercial production, it is necessary to optimize basic crop management practices, such as corm size and plant spacing. Consequently, this study aims to explore the effects of corm size and spacing on the growth, flowering and yield of *gladiolus* cv. Malaviya Shatabdi.

2. MATERIALS AND METHODS

The study was conducted at the Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, during the 2023-2024 growing season. The experimental site is situated at 25° 15' North latitude and 82° 59' East longitude, with an elevation of 103 meters above sea level, near the Ganges river. The region has a subtropical climate characterized by hot summers, mild winters and a distinct monsoon season. The soil at the site is well-drained, alluvial, moderately fertile and has a pH ranging from 6.5 to 7.5. Healthy, disease-free corms of *gladiolus* cv. Malaviya Shatabdi were obtained from the Department of Horticulture and planted at different spacings on November 8, 2023. The experiment was laid out in a Randomized Block Design (RBD) with 24 treatment combinations and three replications. The treatments consisted of four corm sizes (1.0-2.0 cm, 2.1-3.0 cm, 3.1-4.0 cm and 4.1-5.0 cm) and six spacing configurations (30 cm × 20 cm, 30 cm × 25 cm, 30 cm × 30 cm, 30 cm × 40 cm, 20 cm × 20 cm and 20 cm × 30 cm), along with their interactions. Several vegetative, flowering and corm parameters were observed and data were systematically collected and analyzed using two-factor analysis through factorial analysis of variance (ANOVA), which was conducted to determine the significance of differences between treatments and their interactions.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Different corm sizes and spacing were found to be highly effective in significantly increasing the number of leaves per hill. The highest number of leaves per hill (14.95, 15.05 and 14.96) were observed with corms of 4.1-5.0 cm size, a spacing of 30 cm × 30 cm and their interaction, respectively; whereas, minimum number of leaves (6.41) were observed in the combination of smaller corm size (1.0-2.0 cm) and closer

spacing (20 cm × 30 cm). The favourable outcome of larger corms and wider spacing in promoting the number of leaves per hill may be attributed to the reduced competition between plants due to the wider spacing, allowing each plant to better utilize water, nutrients, air and light, which contributes to improved growth. These findings align closely with those of Kareem *et al.* (2013) and Bhande *et al.* (2015). Kumar *et al.* (2016) observed that the highest number of leaves per plant (8.01) were achieved with a spacing of 30 cm × 40 cm in gladiolus.

Table 1. Effect of corm size and spacing on growth and corm parameters in gladiolus cv. Malaviya Shatabdi

	No. of leaves/hill at 90 DAP	Scape width (cm) at 90 DAP	Width of longest leaf (cm) at 90 DAP	Weight of corms/hill (g)	No. of cormels/hill
Corm grade					
C1 (1.0-2.0 cm)	6.62	1.59	1.84	17.36	4.81
C2 (2.1-3.0 cm)	10.87	1.81	1.98	29.41	10.68
C3 (3.1-4.0 cm)	13.29	2.19	2.37	30.68	9.04
C4 (4.1-5.0 cm)	14.95	2.58	2.44	32.39	11.12
C.D. at 5%	1.32	0.05	0.18	4.48	1.35
Spacing					
S1 (30 cm × 20 cm)	12.11	2.42	2.30	27.45	10.86
S2 (30 cm × 25 cm)	13.02	2.46	2.38	26.17	9.77
S3 (30 cm × 30 cm)	15.05	2.81	2.64	30.37	10.93
S4 (30 cm × 40 cm)	14.98	2.48	2.43	28.81	10.25
S5 (20 cm × 20 cm)	13.09	2.43	2.38	26.16	10.71
S6 (20 cm × 30 cm)	13.01	2.34	2.34	29.23	9.27
C.D. at 5%	0.61	0.08	0.08	2.37	0.83
Interaction					
T1 (C1 S1)	6.94	1.54	1.85	16.96	5.82
T2 (C1 S2)	6.39	1.56	1.88	17.31	6.13
T3 (C1 S3)	6.98	1.61	1.91	17.55	6.22
T4 (C1 S4)	6.84	1.57	1.86	17.46	5.98
T5 (C1 S5)	6.57	1.54	1.83	16.98	5.11
T6 (C1 S6)	6.41	1.52	1.81	16.87	4.98
T7 (C2 S1)	10.77	1.79	1.95	27.85	11.21
T8 (C2 S2)	11.02	1.82	1.96	27.99	10.04
T9 (C2 S3)	10.21	1.85	1.99	29.91	11.56
T10 (C2 S4)	10.54	1.81	1.91	28.89	10.21
T11 (C2 S5)	10.41	1.76	1.89	27.41	9.86
T12 (C2 S6)	10.61	1.77	1.88	27.77	10.21
T13 (C3 S1)	13.39	2.18	2.31	29.58	8.98
T14 (C3 S2)	13.63	2.21	2.36	30.12	8.56
T15 (C3 S3)	13.91	2.27	2.41	32.14	9.98
T16 (C3 S4)	13.02	2.25	2.36	31.54	9.65
T17 (C3 S5)	12.99	2.19	2.31	31.11	8.58
T18 (C3 S6)	13.37	2.17	2.29	30.69	9.01
T19 (C4 S1)	14.11	2.54	2.41	32.11	12.24
T20 (C4 S2)	13.25	2.58	2.42	33.36	12.31
T21 (C4 S3)	14.96	2.91	2.71	33.98	13.32
T22 (C4 S4)	14.69	2.61	2.64	32.21	11.29
T23 (C4 S5)	13.54	2.55	2.42	32.04	12.01
T24 (C4 S6)	14.21	2.52	2.39	32.01	11.98
C.D. at 5%	1.19	0.05	0.13	4.06	2.01

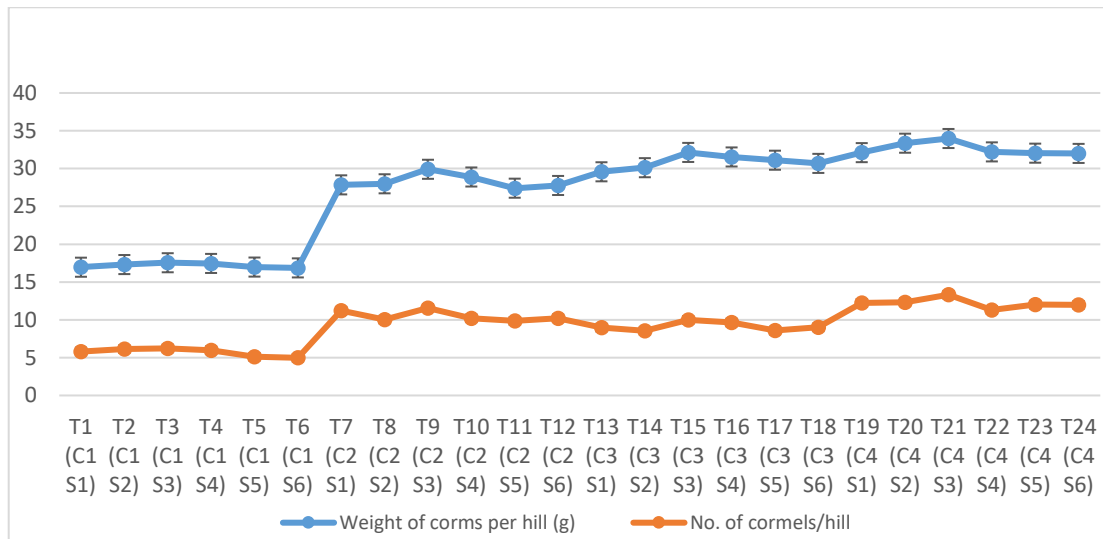


Fig. 1. Interaction effect of corm size and spacing on weight of corms and number of cormels/hill in gladiolus cv. Malaviya Shatabdi

At 90 DAP, the scape width (2.58 cm) was seen when corms of 4.1-5.0 cm were planted. With a spacing of 30 cm x 30 cm, the maximum scape width (2.81 cm) was recorded at 90 DAP. The interaction between corm size and spacing significantly affected scape width as maximum width (2.91 cm) was achieved when corms sized 4.1-5.0 cm were planted with a 30 cm x 30 cm spacing; whereas, minimum scape width (1.52 cm) was observed in the combination of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm x 30 cm). Several studies have confirmed the significant effect of corm size and spacing on scape width, concluding that larger corms and wider spacing lead to better plant growth compared to smaller corms and closer spacing. This result was also in agreement with the research findings of Mathela *et al.* (2019).

Different corm sizes and spacing were found to significantly affect the leaf width. The maximum leaf width (2.44 cm) was observed with larger corms (4.1-5.0 cm). For spacing, the highest leaf width (2.64 cm) was recorded at a wider spacing of 30 cm x 30 cm. The interaction between corm size and spacing also significantly increased the leaf width as the greatest leaf width (2.71 cm) was recorded with the treatment of 4.1-5.0 cm corms and 30 cm x 30 cm spacing; whereas, minimum leaf width (1.81 cm) was observed in the interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm x 30 cm). The enhanced leaf growth due to larger corms and wider spacing can be attributed to reduced competition compared to smaller corms planted

at closer spacing. These results are consistent with the findings of Rana *et al.* (2005), Memon *et al.* (2009) and Laishram & Hatibarua (2013) in gladiolus.

3.2 Corm Parameters

The weight of corms per plant was notably affected by corm size, spacing and their interaction (Table 1). The maximum corm weight per plant (32.39 g, 30.37 g and 33.98 g) was observed with corm size 4.1-5.0 cm, spacing 30 cm x 30 cm and the interaction of corm size (4.1-5.0 cm) with spacing (30 cm x 30 cm), respectively while the lowest corm weight (16.87 g) was observed in the combination of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm x 30 cm). This might be due to the larger corms and wider spacing ensuring better access to nutrients, water and light. This favourable environment supported enhanced growth and corm development, aligning with earlier findings of Dogra *et al.* (2012), Narayan *et al.* (2013), Kumar *et al.* (2016) and Sisodia *et al.* (2023) in gladiolus.

The highest numbers of cormels (11.12 and 10.93) per plant was observed with corm sizes ranging from 4.1-5.0 cm and a spacing of 30 cm x 30 cm. Regarding the interaction between corm size and spacing, the greatest number of cormels per plant (13.32) was recorded with treatment T₂₁ (4.1-5.0 cm corm size and 30 cm x 30 cm spacing); whereas, minimum numbers of cormels per plant (4.98) was observed in smaller

corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). Larger corm size and wider spacing favoured higher cormel production by providing sufficient nutrients, space and energy for the development of new cormels. Reduced competition and better physiological efficiency enhanced cormel formation. These results are consistent with the findings of Amin *et al.* (2013) and Sarkar *et al.* (2014).

3.3 Flowering Parameters

The minimum number of days taken for the opening of the 3rd floret (96.63 days and 95.97 days) and the 5th floret (98.69 days and 98.44 days) were observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. Regarding the interaction of corm size and spacing, the least days to the opening of the 3rd floret (95.97 days) and 5th floret (98.44 days) were recorded with treatment T₂₁ (4.1-5.0 cm corm size and 30 cm × 30 cm spacing); whereas, the maximum number of days for opening of 3rd (102.98 days) and 5th (104.99 days) floret was observed in the interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). These findings align with the results of Kumar *et al.* (2007) and Ramachandrudu and Thangam (2007) in gladiolus.

The largest diameter of the 3rd floret (9.05 cm and 8.98 cm) and 5th floret (8.99 cm and 9.03 cm) were observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. Regarding the interaction effect, the largest

diameter of the 3rd floret (9.11 cm) and 5th floret (8.99 cm) was recorded with the combination of larger corm size (4.1-5.0 cm) and a spacing of 30 cm × 30 cm; whereas, the smallest diameter of 3rd (8.26 cm) and 5th (8.21 cm) floret were observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). Larger corm size and wider spacing promoted greater floret diameter by ensuring better nutrient uptake and reduced inter-plant competition. This enhanced resource availability supported superior floral development. The findings are in agreement with Ramachandrudu and Thangam (2007) in gladiolus.

The maximum length of 3rd floret (10.02 cm and 10.03 cm) and the 5th floret (9.96 cm and 10.03 cm) was observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. Regarding the interaction effect, the largest length of the 3rd floret (10.11 cm) and 5th floret (10.09 cm) was recorded with the combination of larger corm size (4.1-5.0 cm) and a spacing of 30 cm × 30 cm; whereas, the smallest length of 3rd (8.96 cm) and 5th (9.19 cm) floret was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm).

Larger corm size and wider spacing resulted in longer florets by promoting vigorous plant growth and better partitioning of assimilates towards floral organs. Reduced competition enabled optimum resource utilization for floret elongation. These findings are supported by Singh and Singh (2004) and Anwar and Maurya (2005) in gladiolus.

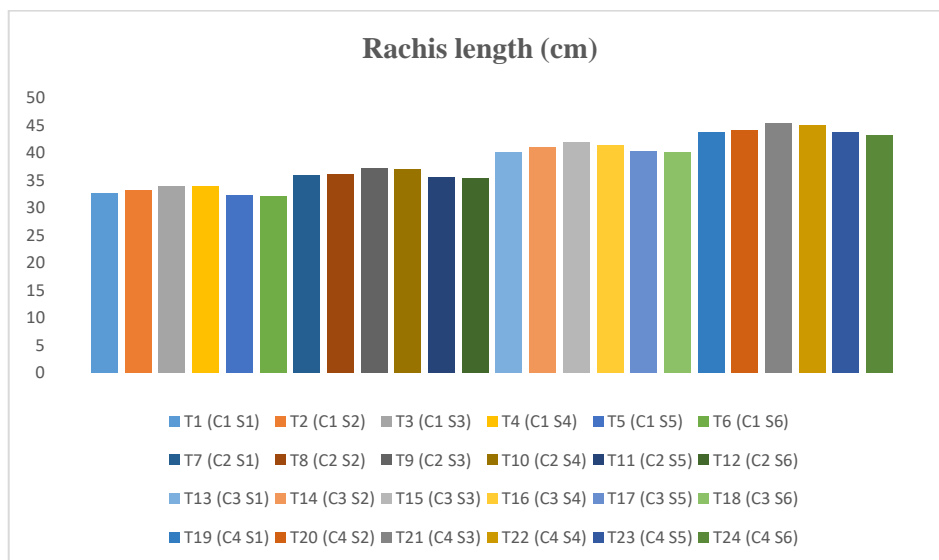


Fig. 2. Interaction effect of corm size and spacing on rachis length (cm) in gladiolus cv. Malaviya Shatabdi

Table 2. Effect of corm size, spacing and their interaction on flowering parameters in gladiolus cv. Malaviya Shatabdi

Treatments	Days to opening of floret		Diameter of floret (cm)		Length of floret (cm)		No. of opened florets/spike	Internodal length (cm)
	3 rd	5 th	3 rd	5 th	3 rd	5 th		
	floret	floret	floret	floret	floret	floret		
Corm grade								
C1 (1.0-2.0 cm)	102.64	104.33	8.32	8.31	9.11	9.31	8.32	3.93
C2 (2.1-3.0 cm)	101.11	103.42	8.70	8.86	9.77	9.78	9.26	4.13
C3 (3.1-4.0 cm)	99.58	101.31	8.99	8.91	9.86	9.92	9.33	4.23
C4 (4.1-5.0 cm)	96.63	98.69	9.05	8.99	10.02	9.96	9.84	4.31
C.D. at 5%	1.26	1.37	0.18	0.11	0.32	0.12	0.33	0.07
Spacing								
S1 (30 cm × 20 cm)	99.72	101.95	8.81	8.75	9.64	9.79	9.18	4.23
S2 (30 cm × 25 cm)	99.31	101.32	9.13	8.82	9.65	9.62	9.02	4.11
S3 (30 cm × 30 cm)	95.97	98.44	8.98	9.03	10.03	10.03	9.83	4.32
S4 (30 cm × 40 cm)	97.64	99.92	8.74	8.71	9.71	9.71	9.21	4.27
S5 (20 cm × 20 cm)	98.71	100.72	8.71	8.23	9.66	9.23	8.95	4.11
S6 (20 cm × 30 cm)	97.93	100.29	8.77	8.44	9.81	9.32	8.96	4.07
C.D. at 5%	1.31	1.38	0.23	0.23	NS	0.25	0.31	0.10
Interaction								
T1 (C1 S1)	102.91	104.98	8.31	8.27	8.97	9.32	8.29	3.89
T2 (C1 S2)	102.63	104.91	8.33	8.29	8.99	9.29	8.31	3.91
T3 (C1 S3)	102.12	104.21	8.37	8.32	9.12	9.36	8.41	3.96
T4 (C1 S4)	102.21	104.39	8.31	8.31	9.09	9.33	8.36	3.89
T5 (C1 S5)	102.89	104.85	8.29	8.24	8.99	9.21	8.24	3.77
T6 (C1 S6)	102.98	104.99	8.26	8.21	8.96	9.19	8.21	3.78
T7 (C2 S1)	101.21	103.96	8.67	8.79	9.63	9.69	9.11	4.09
T8 (C2 S2)	101.11	103.63	8.71	8.85	9.68	9.71	9.21	4.11
T9 (C2 S3)	100.84	102.85	8.75	8.89	9.79	9.81	9.29	4.19
T10 (C2 S4)	100.98	103.01	8.73	8.87	9.76	9.76	9.26	4.16
T11 (C2 S5)	101.36	103.54	8.69	8.74	9.61	9.69	9.17	4.08
T12 (C2 S6)	101.65	103.98	8.64	8.71	9.61	9.68	9.15	4.06
T13 (C3 S1)	99.95	101.39	8.89	8.89	9.79	9.85	9.39	4.19
T14 (C3 S2)	99.68	100.96	8.93	8.91	9.81	9.89	9.41	4.21
T15 (C3 S3)	99.43	100.11	8.99	8.97	9.89	9.94	9.49	4.29
T16 (C3 S4)	99.61	100.24	8.95	8.94	9.86	9.91	9.45	4.26
T17 (C3 S5)	99.87	101.28	8.84	8.89	9.76	9.79	9.37	4.18
T18 (C3 S6)	99.96	101.96	8.81	8.87	9.71	9.76	9.33	4.16
T19 (C4 S1)	96.37	99.12	9.01	8.97	9.98	9.95	9.79	4.24
T20 (C4 S2)	96.11	98.25	8.98	8.97	9.99	9.96	9.83	4.31
T21 (C4 S3)	95.44	98.11	9.11	8.99	10.11	10.09	9.91	4.41
T22 (C4 S4)	95.94	98.26	9.06	8.96	10.06	9.91	9.89	4.39
T23 (C4 S5)	96.09	99.27	8.98	8.93	9.98	9.87	9.81	4.21
T24 (C4 S6)	96.32	99.65	8.96	8.91	10.01	9.85	9.79	4.22
C.D. at 5%	1.27	1.31	0.17	0.09	0.06	0.08	0.27	0.09

The highest number of opened florets per spike (9.84 and 9.83) was observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. In terms of the interaction effect between corm size and spacing, the maximum number of opened florets per spike (9.91) was recorded with treatment T₂₁ (4.1-5.0 cm corm size and 30 cm × 30 cm spacing); whereas, the minimum number of opened florets per spike (8.21) was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). Larger corm size and wider spacing increased the number of opened florets per spike

by enhancing plant vigour and ensuring better nutrient and energy supply to the floral structures. Improved growth conditions reduced stress, leading to fuller floret opening. These findings are consistent with Singh (2000) and Pal *et al.* (2015) in gladiolus.

The length of the rachis and internodal was enhanced with larger corm sizes, specifically 4.1-5.0 cm. The maximum length of the rachis (44.51 cm and 43.79 cm) and internodal (4.31 cm and 4.32 cm) was observed with 4.1-5.0 cm corms and a spacing of 30 cm × 30 cm, respectively. In

terms of the interaction effect, treatment T₂₁ (4.1-5.0 cm corm size and 30 cm × 30 cm spacing) resulted in the greatest rachis (45.28 cm) and internodal (4.41 cm) length; whereas, the minimum length of rachis (32.11 cm) and internodal (3.78 cm) was found in the interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). The increased rachis and internodal length observed with larger corms and wider spacing can be attributed to the optimal growing conditions that supported greater plant elongation and structural development. This combination reduced competition for resources, facilitating better growth. These findings are consistent with Singh and Singh (2004) in gladiolus.

4. CONCLUSION

The findings of current study highlight the significant role of both corm size and spacing in optimizing the growth, flowering, and yield attributes of gladiolus cv. Malaviya Shatabdi. The use of larger corms (4.1-5.0 cm) combined with wider spacing (30 cm × 30 cm) consistently improved vegetative vigour, floral characteristics and corm production. These findings offer direct, practical recommendations for gladiolus growers as using larger planting materials and providing sufficient spacing can enhance marketable spike quality and multiplication rate. This is especially beneficial for commercial floriculture, where uniform flowering and higher floret size are key to profitability. Given the ornamental and economic value of gladiolus in the cut flower industry, these results have clear commercial relevance for enhancing productivity under field conditions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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