

RESEARCH PAPER

Impact of Corm Grade and Spacing on Growth, Flowering and Corm Attributes in *Gladiolus* cv. Malaviya Shatabdi

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ABSTRACT

The experiment was conducted at Horticulture Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, during the 2023-24 growing season to evaluate the impact of corm size and spacing on the growth, flowering and yield of *gladiolus* cv. Malaviya Shatabdi. The experiment involved four different 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). Both corm size and spacing significantly affected all parameters examined. The largest corm size (4.1-5.0 cm) resulted in earlier spike initiation (78.91 days), tallest plant (58.61 cm), longest spike (65.58 cm), longest leaf (49.81 cm) and the greatest number of corms (2.97 per plant). Among the spacing treatments, wider spacing (30 cm × 30 cm) produced tallest plant (58.61 cm), longest spike (65.78 cm), longest leaf (49.58 cm), along with more number of corms (2.84 per plant). The combination of the largest corm (4.1-5.0 cm) and wider spacing (30 cm × 30 cm) resulted in the tallest plant (53.96 cm), longest spike (65.89 cm), longest leaf (50.27 cm) and the most corms (2.78 per plant). The smallest corm (1.0-2.0 cm) with closer spacing (20 × 30 cm) showed the latest inflorescence initiation (86.17 days) and the smallest plant height (40.75 cm).

HIGHLIGHTS

- ① Larger corms significantly enhance vegetative growth, early spike emergence, longer spikes and higher floret count due to greater nutrient reserves. This results in better-quality flowers and increased commercial value.
- ② Wider spacing promotes better aeration, light penetration and nutrient availability, leading to stronger plant growth and more robust spike development. However, denser spacing may increase plant population per unit area, affecting individual plant vigour.

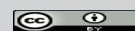
Keywords: *Gladiolus*, growth, corm size, spacing, flowering

Gladiolus (*Gladiolus grandiflora*), commonly known as "Sword Lily," is a herbaceous annual flower native to South Africa. It belongs to the monocot family Iridaceae. This ornamental, corm-bearing plant is primarily grown for its cut flowers, though it is also occasionally used in landscaping. *Gladiolus* produces strikingly beautiful flowers and there is significant consumer demand for them. To meet this demand, it is crucial to ensure that *gladiolus* flowers are available throughout the year. *Gladiolus*

is one of the few plants that produce visually appealing cut flowers with long spikes, which are essential components for many floral arrangements, ranging from table centerpieces to large bouquets. It is grown in many tropical and subtropical regions worldwide. Typically, a single mother corm

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produces one daughter corm of standard size along with a few cormels. Cormels are auxiliary buds located on the corm, a thickened, compressed stem that serves as a resting and propagating organ. It takes two to three seasons for the cormels to develop into standard flower spikes and daughter corms. However, the commercial production of corms and cormels often fails to meet the local demand for planting material, leading to higher corm costs. Various factors, such as corm size, spacing, planting depth, planting time and fertilizer management, significantly impact the production and quality of gladiolus flowers (Kumar *et al.* 2016). Among these, corm size and spacing are particularly important. Larger corms tend to produce more flowers, corms and cormels compared to smaller ones. To achieve quality spike production, it is essential to standardize improved crop management techniques for each location where the crop is grown. In addition to climatic factors, plant spacing plays a crucial role in producing a higher yield of better-quality spikes and corms. Basic crop management practices, such as plant spacing and corm size, must be optimized for large-scale commercial cultivation. Therefore, the current study was conducted to investigate the impact of spacing and corm size on the growth, flowering and corm yield of gladiolus cv. Malaviya Shatabdi.

MATERIALS AND METHODS

The present study was carried out 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 objective was to evaluate the effect of corm size and spacing on the growth, flowering and corm characteristics of gladiolus cv. Malaviya Shatabdi. The experimental site is located at a latitude of 25° 15' North and longitude of 82° 59' East, with an altitude of 103 meters above sea level, near the Ganges river. The region experiences a subtropical climate with hot summers, moderate winters and a distinct monsoon season. The soil at the site is well-drained, alluvial and moderately fertile and has a pH between 6.5 and 7.5. Healthy, disease-free gladiolus corms of cv. Malaviya Shatabdi were sourced from the Department of Horticulture and planted at varying spacing in November, 2023. The experiment was

designed in a Randomized Block Design (RBD) with 24 treatment combinations and three replications. The treatments included 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 (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. Various vegetative, flowering and corm attributes were observed, including the number of sprouts per hill, plant height (cm), length of the longest leaf (cm), days to spike emergence, days to colour show, days to floret opening, floret diameter (cm), floret length (cm), number of florets per spike, flowering duration, spike length (cm), weight of cormels per hill (g), number of corms per hill and corm diameter (mm). Data were carefully recorded and analyzed using Analysis of Variance (ANOVA) to assess the significance of differences among treatments.

RESULTS AND DISCUSSION

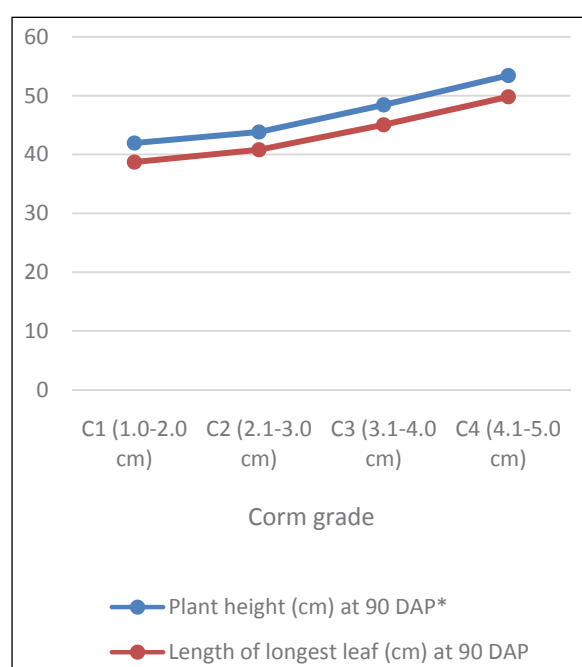
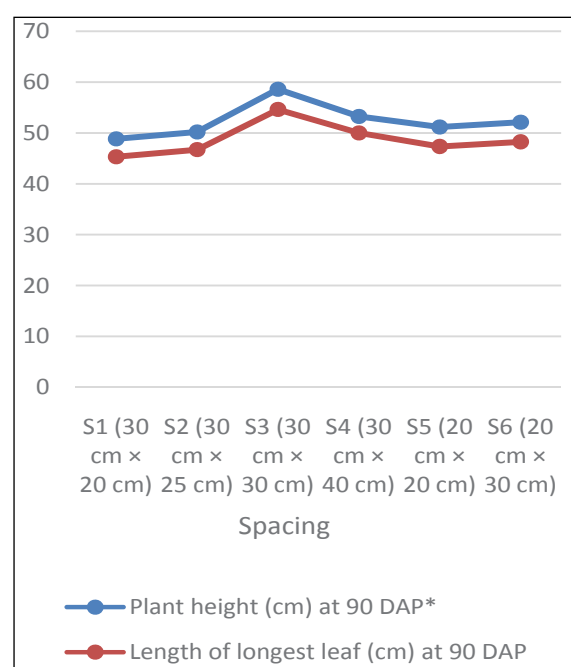
Growth parameters

The number of sprouts per hill was significantly affected by corm size, spacing and their interaction (Table 1 and 2). Larger corms and wider spacing (2.94 and 3.04, respectively) led to a significant increase in the number of sprouts per hill. However, the interaction of corm size (4.1-5.0 cm) and spacing (30 cm × 30 cm) further significantly enhanced the number of sprouts per hill (3.12); whereas, the least no. of sprouts per hill (1.11) was observed in the interaction of smaller corm size (4.1-5.0 cm) and closer spacing (30 cm × 20 cm). This might be due to larger corms and wider spacing provided more nutrients and space per plant, reducing competition and promoting sprout development, while their interaction created optimal conditions for maximum sprouting as observed in the work done by Singh and Singh (2004) and Sisodia *et al.* (2023).

At 90 DAP, the tallest plant (53.42 cm) was seen when corms of 4.1-5.0 cm were planted (Table 1). With a spacing of 30 cm × 30 cm, the maximum plant height (58.61 cm) was recorded at 90 DAP (Table 2). The interaction between corm size and spacing significantly affected plant height as the tallest plants (59.02 cm) were achieved when corms sized 4.1-5.0 cm were planted with a 30 cm × 30 cm spacing; whereas, minimum plant height (40.75 cm) was observed in smaller corm size (1.0-2.0 cm)

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

Treatments	No. of sprouts/hill	Plant height (cm) at 90 DAP*	Length of longest leaf (cm) at 90 DAP	Weight of cormels/hill (g)	Days to spike emergence (days)	Days to colour show (days)
Corm grade						
C1 (1.0-2.0 cm)	1.07	41.95	38.71	0.11	85.69	96.36
C2 (2.1-3.0 cm)	2.08	43.83	40.81	0.17	82.87	94.12
C3 (3.1-4.0 cm)	2.88	48.43	45.05	0.14	81.15	92.26
C4 (4.1-5.0 cm)	2.94	53.42	49.81	0.19	78.91	89.77
C.D. at 5%	0.23	2.71	1.87	NS	1.21	0.95
Spacing						
S1 (30 cm × 20 cm)	2.98	48.85	45.32	0.16	81.62	92.68
S2 (30 cm × 25 cm)	2.85	50.21	46.72	0.13	81.21	92.25
S3 (30 cm × 30 cm)	3.04	58.61	54.62	0.19	78.24	89.08
S4 (30 cm × 40 cm)	2.81	53.26	50.01	0.16	79.60	90.61
S5 (20 cm × 20 cm)	2.08	51.19	47.34	0.16	80.82	91.97
S6 (20 cm × 30 cm)	2.77	52.12	48.26	0.17	79.88	90.68
C.D. at 5%	0.41	1.90	1.90	NS	1.38	1.33

**Fig. 1:** Effect of corm grade on plant height (cm) and leaf length at 90 DAP in gladiolus cv. Malaviya Shatabdi**Fig. 2:** Effect of spacing on plant height (cm) and leaf length at 90 DAP in gladiolus cv. Malaviya Shatabdi

and closer spacing (20 cm × 30 cm). Several studies have confirmed the significant effect of corm size and spacing on plant height, concluding that larger corms and wider spacing lead to better plant growth compared to smaller corms and closer spacing due to enhanced nutrient reserves and reduced competition, creating favorable conditions for vigorous vegetative growth (Bijimol and Singh,

2001; Uddin *et al.* 2002). 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 length. The maximum leaf length (49.81 cm) was observed with larger corms (4.1-5.0 cm). For spacing, the highest leaf length (49.58 cm) was recorded at a wider spacing of 30

Table 2: Interaction effect of corm grade and spacing on growth and flowering parameters in gladiolus cv. Malaviya Shatabdi

Treatments	No. of sprouts/hill	Plant height (cm) at 90 DAP*	Length of longest leaf (cm) at 90 DAP	Weight of cormels/hill (g)	Days to spike emergence (days)	Days to colour show (days)
Interaction						
T1 (C1 S1)	1.11	40.98	38.06	0.11	86.11	96.54
T2 (C1 S2)	1.27	41.01	38.87	0.11	85.99	96.34
T3 (C1 S3)	2.01	42.05	39.11	0.12	85.12	95.98
T4 (C1 S4)	2.21	41.98	39.05	0.10	85.29	96.05
T5 (C1 S5)	1.33	41.56	38.78	0.09	86.12	96.57
T6 (C1 S6)	1.29	40.75	37.98	0.09	86.17	96.97
T7 (C2 S1)	2.27	43.11	39.95	0.15	83.01	95.31
T8 (C2 S2)	2.31	43.78	40.19	0.16	83.09	95.17
T9 (C2 S3)	2.86	44.45	41.25	0.17	82.99	94.11
T10 (C2 S4)	2.88	44.06	41.11	0.17	83.11	94.19
T11 (C2 S5)	2.37	43.87	40.32	0.16	83.27	95.57
T12 (C2 S6)	2.41	42.17	40.19	0.15	83.96	95.64
T13 (C3 S1)	2.88	47.94	44.14	0.11	82.98	93.11
T14 (C3 S2)	2.82	48.11	45.12	0.12	81.94	93.05
T15 (C3 S3)	2.79	49.23	45.97	0.14	81.11	92.11
T16 (C3 S4)	2.73	48.98	45.26	0.13	81.29	92.99
T17 (C3 S5)	2.83	47.39	44.19	0.12	82.11	93.36
T18 (C3 S6)	2.81	47.23	44.08	0.12	82.09	93.37
T19 (C4 S1)	2.74	51.12	48.86	0.17	79.87	90.99
T20 (C4 S2)	2.79	52.71	48.99	0.17	79.69	90.23
T21 (C4 S3)	3.12	59.02	50.27	0.19	78.05	89.17
T22 (C4 S4)	2.88	57.88	49.69	0.18	78.27	90.07
T23 (C4 S5)	2.78	52.04	48.97	0.16	79.23	90.89
T24 (C4 S6)	2.81	51.99	48.63	0.15	79.63	91.02
C.D. at 5%	0.32	1.98	1.81	0.04	1.29	0.89

cm × 30 cm. The interaction between corm size and spacing also significantly increased the leaf length as the greatest leaf length (50.27 cm) was recorded with the treatment of 4.1-5.0 cm corms and 30 cm × 30 cm spacing; whereas, minimum leaf length (37.98 cm) was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 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 Hatibarna and Paswan (2001), Memon *et al.* (2009), Laishram and Hatibarua (2013) and Sisodia *et al.* (2023) in gladiolus.

Flowering parameters

The number of days required for spike initiation and colour show was significantly influenced by the different corm grades, spacing and their interaction. The shortest duration for spike initiation (78.91 days and 78.24 days) and colour show (89.77 days and 89.08 days) were observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. When considering the interaction between corm size and spacing, the minimum days for spike initiation (78.05 days) and colour show (89.17 days) was recorded in the treatment T₂₁ (4.1-5.0 cm corm size and 30 cm × 30 cm spacing); whereas, the maximum number of days (86.17) was observed in interaction

of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). This might be due to larger corms and wider spacing accelerated spike initiation and colour show by promoting early and vigorous plant development through better energy reserves and reduced stress as observed in the study of Singh and Singh (2004) and Bhat and Khan (2007).

The minimum number of days for the opening of the first floret (94.63 days and 104.12 days) and the last floret (96.63 days and 104.61 days) was 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 first floret (94.01 days) and last floret (104.02 days) was 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 first (100.87) and last (110.36) floret was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). This might be due to larger corms and wider spacing reduced the time to floret opening by supporting faster floral development through improved nutrient availability and reduced plant competition as found in the results of Kumar *et al.* (2007) and Ramachandrudu and Thangam (2007).

The largest diameter of the first floret (9.15 cm and 9.22 cm) and last floret (8.99 cm and 9.03 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 diameter of the first floret (9.17 cm) and last floret (8.98 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 first (8.11 cm) and last (8.21 cm) floret was observed in interaction of

smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). The increase in floret diameter with larger corms and wider spacing is attributed to better energy reserves and enhanced nutrient uptake, promoting fuller floret formation. These results align with the findings of Ramachandrudu and Thangam (2007).

The maximum length of the first floret (10.14 cm and 10.18 cm) and the last 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 first floret (10.19 cm) and last 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 first (9.19 cm) and last (9.19 cm) floret was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). Greater floret length resulted from larger corms and wider spacing due to improved nutrient reserves and reduced crowding, which supported better floral elongation and development as observed in the findings of Singh (2004) and Anwar and Maurya (2005).

The highest number of florets per spike (13.07 and 13.11) was observed with corms sized 4.1-5.0 cm and a spacing of 30 cm × 30 cm, respectively. In terms of the interaction, the maximum number of florets per spike (13.31) was recorded with treatment T21 (4.1-5.0 cm corm size and 30 cm × 30 cm spacing); whereas, the minimum number of florets per spike (10.06) was observed in interaction of smaller corm size (1.0-2.0 cm) and closer spacing (20 cm × 30 cm). This might be due to larger corms provide greater nutrient reserves, promoting robust spike formation and wider spacing reduces competition, enabling better resource allocation for increased

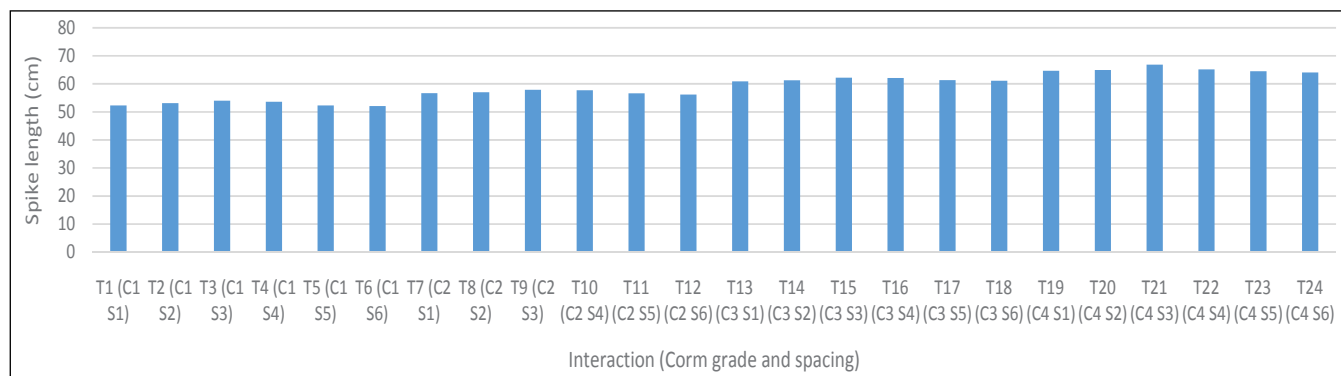


Fig. 3: Combined effect of corm grade and spacing on spike length (cm) in *gladiolus* cv. Malaviya Shatabdi

Table 3: Effect of corm grade and spacing on flowering and corm parameters in gladiolus cv. Malaviya Shatabdi

Treatments	Days to opening of floret		Diameter of floret (cm)		Length of floret (cm)		No. of florets/spike	Flowering duration (days)	Spike length (cm)	No. of corms/hill	Diameter of corms (mm)
Corm grade	1 st floret	Last floret	1 st floret	Last floret	1 st floret	Last floret					
C1 (1.0-2.0 cm)	100.22	109.33	8.26	8.31	9.28	9.31	10.32	12.06	52.23	1.05	26.12
C2 (2.1-3.0 cm)	99.16	108.53	8.92	8.86	9.92	9.78	11.22	13.59	57.57	1.98	34.01
C3 (3.1-4.0 cm)	97.41	106.31	9.04	8.91	10.05	9.92	11.87	14.25	61.37	2.12	43.39
C4 (4.1-5.0 cm)	94.63	104.12	9.15	8.99	10.14	9.96	13.07	15.43	65.58	2.97	50.43
C.D. at 5%	1.29	1.28	0.09	0.11	0.09	0.12	0.26	0.89	2.71	0.27	4.39
Spacing											
S1 (30 cm × 20 cm)	97.68	106.73	8.77	8.75	9.86	9.79	11.93	14.52	62.22	2.41	39.81
S2 (30 cm × 25 cm)	97.34	106.45	8.86	8.82	9.86	9.62	12.10	14.77	62.62	2.11	45.29
S3 (30 cm × 30 cm)	93.92	103.51	9.22	9.03	10.18	10.03	13.11	16.06	65.78	2.84	50.31
S4 (30 cm × 40 cm)	95.69	104.85	9.05	8.71	10.03	9.71	11.81	14.76	63.36	2.21	48.31
S5 (20 cm × 20 cm)	96.62	105.56	8.28	8.23	9.29	9.23	11.37	14.33	60.89	1.96	39.91
S6 (20 cm × 30 cm)	95.88	104.61	8.51	8.44	9.53	9.32	11.62	15.01	62.62	1.44	46.46
C.D. at 5%	1.15	1.21	0.11	0.23	0.13	0.25	0.37	0.75	1.73	0.30	4.45

Table 4: Interaction effect of corm grade and spacing on flowering and corm parameters in gladiolus cv. Malaviya Shatabdi

Treatments	Days to opening of floret		Diameter of floret (cm)		Length of floret (cm)		No. of florets/spike	Flowering duration (Days)	Spike length (cm)	No. of corms/hill	Diameter of corms (mm)
Interaction	1 st floret	Last floret	1 st floret	Last floret	1 st floret	Last floret					
T1 (C1 S1)	100.67	110.31	8.24	8.27	9.25	9.32	10.21	11.98	52.29	1.04	25.94
T2 (C1 S2)	100.33	109.98	8.25	8.29	9.26	9.29	10.27	12.07	53.11	1.09	26.13
T3 (C1 S3)	100.19	109.11	8.28	8.32	9.29	9.36	10.36	12.36	53.98	1.11	27.75
T4 (C1 S4)	100.23	109.36	8.27	8.31	9.28	9.33	10.29	12.24	53.65	1.09	27.15
T5 (C1 S5)	100.69	110.01	8.11	8.24	9.21	9.21	10.11	12.01	52.28	1.04	26.11
T6 (C1 S6)	100.87	110.36	8.11	8.21	9.19	9.19	10.06	11.96	52.11	1.06	25.98
T7 (C2 S1)	99.89	108.87	8.87	8.79	9.87	9.69	11.17	13.75	56.69	2.11	32.01
T8 (C2 S2)	99.17	108.11	8.88	8.85	9.89	9.71	11.29	13.77	57.05	1.98	33.36
T9 (C2 S3)	98.89	107.66	8.92	8.89	9.93	9.81	11.36	13.84	57.89	2.31	34.96
T10 (C2 S4)	99.16	107.98	8.91	8.87	9.91	9.76	11.31	13.81	57.69	1.98	34.09
T11 (C2 S5)	99.88	108.93	8.77	8.74	9.84	9.69	11.17	13.74	56.64	2.01	33.21
T12 (C2 S6)	99.96	108.98	8.76	8.71	9.83	9.68	11.14	13.69	56.21	2.11	32.21
T13 (C3 S1)	97.61	106.14	8.98	8.89	9.98	9.85	11.74	14.11	60.89	2.14	41.67
T14 (C3 S2)	97.56	105.99	8.99	8.91	9.99	9.89	11.75	14.65	61.25	2.34	42.23
T15 (C3 S3)	97.11	105.11	9.06	8.97	10.09	9.94	11.81	15.11	62.21	2.46	44.21
T16 (C3 S4)	97.21	105.37	9.04	8.94	10.04	9.91	11.79	14.98	62.11	2.21	43.35
T17 (C3 S5)	97.89	106.57	8.97	8.89	9.89	9.79	11.67	14.05	61.29	1.98	41.12
T18 (C3 S6)	97.86	106.63	8.92	8.87	9.88	9.76	11.61	14.09	61.11	2.01	41.26
T19 (C4 S1)	95.11	105.01	9.12	8.97	10.12	9.95	12.89	15.25	64.65	2.65	48.87
T20 (C4 S2)	95.06	104.21	9.14	8.97	10.14	9.96	12.91	15.65	64.98	2.71	49.98
T21 (C4 S3)	94.01	104.02	9.17	8.99	10.19	10.09	13.31	15.98	66.89	3.01	51.23
T22 (C4 S4)	94.12	104.11	9.15	8.96	10.16	9.91	12.96	15.68	65.19	2.47	49.99
T23 (C4 S5)	95.22	104.99	9.11	8.93	10.11	9.87	12.84	15.31	64.51	2.55	48.98
T24 (C4 S6)	94.99	105.05	9.04	8.91	10.09	9.85	12.33	15.28	64.11	2.61	49.69
C.D. at 5%	1.19	1.18	0.08	0.09	0.07	0.08	0.23	0.91	1.98	0.61	4.12

floret production as observed in the studies of Singh (2000) and Pal *et al.* (2015).

Corm parameters

The highest number of corms (2.97 and 2.84) per plant was observed with corm sizes ranging from 4.1–5.0 cm and a spacing of 30 cm × 30 cm. Regarding the interaction between corm size and spacing, the greatest number of corms per plant (3.01) was recorded with treatment T₂₁ (4.1–5.0 cm corm size and 30 cm × 30 cm spacing); whereas, minimum numbers of corms per plant (1.04) was observed in smaller corm size (1.0–2.0 cm) and closer spacing (20 cm × 20 cm). A decrease in corm production per plant was noted with smaller corm sizes and closer spacing, likely due to the limited nutrient availability from the smaller corms and reduced spacing, which impacted corm development as observed in the findings of Sisodia *et al.* (2023).

The largest corm diameter (50.43 mm, 50.31 mm and 51.23 mm) was recorded with corm size 4.1–4.5 cm, 30 cm × 30 cm spacing and the interaction of 4.1–5.0 cm corm size with 30 cm × 30 cm spacing, respectively; whereas, smallest corm diameter (25.94 mm) was observed in interaction of smaller corm size (1.0–2.0 cm) and closer spacing (30 cm × 20 cm). Smaller corm sizes and closer spacing resulted in reduced corm diameters, possibly due to the shading effect of plants on each other, which affected photosynthesis and dry matter accumulation. These findings align with the results of Dogra *et al.* (2012), Amin *et al.* (2013) and Sarkar *et al.* (2014).

CONCLUSION

Based on the results of the current study, which examined various treatment combinations of corm sizes, spacing and their interactions on the morphological, flowering and corm attributes of *gladiolus* cv. Malaviya Shatabdi, it can be concluded that the most promising overall results were achieved through the interaction of a corm size of 4.1–5.0 cm and a spacing of 30 cm × 30 cm. This interaction significantly enhanced the plant's growth and development, surpassing the effects of the individual treatments alone. The combined effect of these two factors played a crucial role in improving various morphological and flowering characteristics.

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