OPEN ACCESS

GRS Journal of Multidisciplinary Research and Studies

Abbriviate Tittle- GRS J Mul Res Stud

ISSN *(Online)- 3049-0561*

https://grspublisher.com/journal-details/GRSJMRS

Vol-2, Iss-5 (May- 2025)

Optimization of Planting Depth and Spacing for Improvement of Growth and Yield (Flowers and Corms) of Gladiolus grandifloras L. in Bangladesh

Sadia Afrin[1], Mahmudul Hasan Chowdhury[2]

[1]Principal Scientific Officer, Soil Resource Development Institute, Ministry of Agriculture, Bangladesh.

[2]Scientific Officer, Soil Resource Development Institute, Ministry of Agriculture, Bangladesh.

***Corresponding Author :**Sadia Afrin

"Principal Scientific Officer, Soil Resource Development Institute, Ministry of Agriculture, Bangladesh"

Received: 12.04.2025 **Accepted: 01.05.2025** **Published: 13.05.2025**

Abstract: Gladiolus is a commercially important cut flower in many countries. However, scientific research on its cultivation under the climatic conditions of Bangladesh is quite limited, representing a significant research gap. To address this, a two-factor experiment (planting depth and spacing) was completed by a Randomized Complete Block Design (RCBD) where three replications were available. Each factors contained 3 levels namely spacing 1 (25 cm x 10 cm, S_1), spacing 2 (25 cm x 15 cm, S_2) and spacing 3 (25 cm x 20 cm, S_3), depth 1 (5 cm, D_1), depth 2 (7 cm, D_2 and depth 3 (9 cm, D_3). Three blocks were divided into 9 plots. The plot size was 120 cm x 100 cm. The plot-plot spacing was 50 cm in both sides. The widest spacing ensured tallest plant (54.49 cm), maximum number of leaves (8.90), tallest spike (85.68 cm), maximum weight of individual corm (44.39 gm) per plant, whereas maximum yield of spike (11.40 t/ha) and corm (7.99 t/ha) was obtained from the closest spacing. Similarly the shallowest depth of planting produced maximum weight (6.54 t/ha) and number of cormel (38.43 / plant) whereas the deepest depth produced tallest (82.56 cm) and heaviest (8.71 t/h) spike. Combination of S_1 and D_3 produced the maximum yield of spike (12 t/h) but S_1 combine with D_1 produced the highest yield of corm (8.29 t/ha).

Keywords: *Gladiolus, Plant Depth, Plant Spacing, Flowers, Corms, Cut Flower*.

Introduction

Gladiolus (Gladiolus grandiflorus L.) is a widely cultivated bulbous cut flower. Known for its vibrant colors, it is often used for decorative purposes (Bose and Yadav, 1989). Negi and Raghava (1986) reported that Gladiolus continues to see rising demand in both global and local markets for its wide variation in size, color, form, and vase life. In Bangladesh, the limited availability of alternative cut flowers like tuberose during the winter season provides a unique opportunity for gladiolus to gain popularity. The cultivation of gladiolus in India began in the nineteen century, and over time, it steadily became more popular in Bangladesh. Today, its commercial cultivation has expanded significantly in regions such as Jessore, Satkhira, Gazipur, and Savar. Banker and Mukhopadhyay (1980) did an experiment in order to find the effects of depth of planting, corm size and spacing on the production of corms and flowers of gladiolus. Yadav and Tyagi (2007) recommended the largest cut corm produced the highest leaves' number per plant, spike length, spikes per plant, corms per plant, florets per spike, and the greatest diameter of new corms. The widest spacing (25 cm × 30 cm) led to the tallest plants and also maximized the spikes, florets per spike, spike length, number of leaves, cormels per plant, and corm diameter. In contrast, deeper planting negatively affected corm and cormel production and delayed flowering. Both spacing and planting depth significantly influenced flowering, corm development, and cormel yield. Therefore, optimizing these two factors holds potential for improving the yield and quality of gladiolus flowers, corms, and cormels. In light of these considerations, this study was run to determine not only the optimal planting depth but also spacing for enhancing gladiolus production.

Materials and Methods

Location of Experiment

The experiment was conducted in a climate (subtropical) characterized by three seasons: rainy, winter (dry) and monsoon seasons. The site was located on medium high land, featuring shallow red-brown terrace soil of Tejgaon series (AEZ-28). The soil had a measured pH of 5.6.

Treatments and design of the experiment

A two-factor experiment, involving planting depth and spacing, was designed in a Randomized Complete Block Design (RCBD) having three replications of every treatment. Each factor had three levels: spacing levels were S_1 (25 cm × 10 cm), S_2 (25 cm × 15 cm), and S_3 (25 cm × 20 cm); while planting depths were D_1 (5 cm), D_2 (7 cm), and D_3 (9 cm). The experiment included three blocks, each divided into nine plots, resulting in a total of 27 unit plots (3 blocks × 9 plots). Nine treatment combinations (3 spacing × 3 depths) were randomly assigned across the plots. Each unit plot measured 120 cm × 100 cm, with a 50 cm spacing between plots on all sides.

Land preparation, seeding and cultural operations

An HF power tiller was used to plough and open the experimental field. Prior to the final land preparation, clods were broken, and weeds were removed. Manures and fertilizers were incorporated with basal doses at the time of final preparation of land. The applied rates were: 100 tons of cow dung, 200 kg of urea, 225 kg of TSP, and 190 kg of Muriate of Potash (MP) per hectare. The total amount of cow dung and TSP was used at the time of final preparation of land, while MP and urea were applied in two equal portions at 25 and 50 days after the period of corm planting. Gladiolus corms were sourced from Ananda Nursery, Savar Bazar, Dhaka (with a voucher deposited at HF). Uniformly sized corms were selected and treated to prevent seed-borne microbial contamination prior to planting. Planting was carried out according to the designated depth and spacing treatments. Light irrigation was applied immediately after planting. Regular weeding was performed as needed. To promote aeration and retain soil moisture, mulching was done by breaking the soil crust after irrigation. Flood irrigation was provided four times during the plant growth period. Earthing up was conducted twice—first at 25 days and again at 50 days after planting. Bamboo stakes were used to support the plants, and spikes were tied to the stakes to prevent lodging.

Data Collection

Gladiolus spikes were harvested when the basal florets began to show color, indicating readiness. Corms and cormels were collected by digging the soil once they had fully matured. Data were noted from ten plants (randomly selected) in each unit plot. Observations included: days required for 50% emergence (time taken for half of the crop to emerge) and 50% flowering (time taken for 50% of the spikes to be ready for harvest); average plant height; average number of leaves per plant; leaf length; spike length; rachis length; number of florets per spike; weight of individual spikes; and yield of corms and cormels (both by weight and number).

Statistical analysis

The collected data for the various observed parameters were statistically analyzed by the MSTAT computer software package. Analysis of variance (ANOVA) was done using the F-test (variance ratio) to determine the significance of differences among treatments. When significant differences were found, the Least Significant Difference (LSD) test was used for comparing treatment means.

Results and Discussion

Effect of spacing and depth of planting on the growth and yield contributing characters of gladiolus

- **Time required for plant emergence**

The timing of gladiolus emergence was recorded and compared only when at least 50% of the plants had emerged in each replication, across both planting depth and spacing treatments. A clear inverse relationship was observed between plant spacing and emergence time—wider spacing led to earlier emergence. Spacing significantly influenced the number of days which was required for 50% plant emergence (Figure 1). The maximum days (7.29) were needed for the spacing of 25 cm x 10 cm and while the minimum time (5.69) was found for 25 cm x 20 cm. Planting depth also had an effect on emergence. As planting depth increased, the time required for emergence also increased. The maximum days (8.07) for plant emergence were required at 9 cm of planting depth and the minimum (5.20 days) was counted at 5 cm of that. These results support the output of Konoshima (1980). Post-hoc analysis revealed that the interaction between spacing and planting depth also significantly affected the time to 50% emergence. The seed planted with 25 cm x 10 cm of spacing at 9 cm depth needed the maximum days (10.29) to emerge whereas; minimum days (4.97) were responsible for the combination of spacing 25 cm x 20 cm with depth of 5 cm.

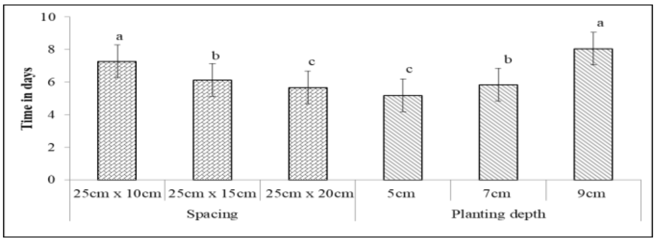

Figure 1. Emerging of plants was significantly affected by factors, spacing and planting depth.

- **Vegetative growth of plant**

Differences in vegetative growth were observed for all treatments at 30, 45, 60, and 75 days after the time of planting. A significant effect of plant spacing on gladiolus plant height was noted at 30 DAP and 75 DAP, while no significant differences were observed at 45 DAP and 60 DAP. At 30 DAP, the plant height (47.20 cm) (highest) was recorded for 25 cm x 20 cm and shortest (44.79 cm) plant height was found on 25 cm x 10 cm. The plant height (highest) (54.49 cm) was observed at a spacing of 25 cm × 20 cm, while the plant height (shortest) (51.54 cm) was recorded at 25 cm × 10 cm at 45 DAP. This difference may be attributed to the fact that plants at wider spacing have greater access to nutrients and sunlight, enhancing photosynthesis. Similar findings were reported by Nilimesh and Roychowdhury (1989), Mollah et al. (1995), and Deswal et al. (1983), who also observed maximum plant height at the widest spacing. Planting depth had a significant effect on plant growth at 30 DAP, 45 DAP, and 60 DAP. However, at 75 DAP, plant height varied significantly across different planting depths. The tallest (70.80 cm) plant height was recorded at 9 cm of planting depth and the shortest (69.79 cm) was found at D_2 7 cm of that. In combination, we observed no significant effect of both spacing and planting depth on plant height (Table 2). This finding observed similar trends in the study by Syamal et al. (1987).

- **Number of leaves per plant and length of leaves**

Spacing significantly influenced number of leaves per plant (NLP). NLP was found as increasing with increasing of spacing. At 30 DAP the maximum (3.78) NLP was recorded for S_3 (25 cm x 20 cm). The maximum (5.65) NLP was recorded from S_3 (25 cm x 20 cm) and the minimum (5.25) NLP was from S_1 25 cm x 10 cm at 45 DAP. At 60 DAP the maximum (7.26) NLP was from S_3 (25 cm x 20 cm) while the minimum (6.76) NLP was from S_1 (25 cm x 10 cm) spacing. The maximum (8.90) NLP was from S_3 (25 cm x 20 cm) and the minimum (8.08) NLP was from S_1 (25 cm x 10 cm) at 75 DAP. Gowda (1987) also got a better result with the widest spacing. No statistically significant effect on NLP was found for planting depth or the combined effect of spacing and planting depth. Syamal et al. (1987) reported a similar trend. The length of leaves per plant (LLP) was not significantly affected by spacing at any of the days after planting (DAP) (Table 1). However, planting depth had a statistically significant effect on LLP at 30 and 45 DAP, though it had no significant impact at 60 and 75 DAP (Table 1). At 30 DAP, the maximum (42.30 cm) LLP was recorded from 5 cm and the minimum (35.43 cm) was found from 7 cm. The maximum (48.00 cm) LLP was obtained from D_1 (5 cm) and the minimum (43.76 cm) was recorded from D_2 (7 cm) at 45 DAP. In overall the length of leaves for intermediate depth (7 cm) was found minimum. The effect of spacing and planting depth (combined) on leaf length was found to be statistically non-significant at 30, 45, 60, and 75 DAP (Table 1). A same trend was observed by Syamal et al. (1987).

- **Time required for emerging of inflorescence**

Similar to the time required for plant emergence, the days required for inflorescence emergence were also observed, and it found a significantly influence on the emergence of inflorescences by both spacing and planting depth. The longest time (in days) (66.67) was recorded at the spacing of 25 cm × 10 cm, while the shortest time (in days) (63.89) was observed at 25 cm × 20 cm (Table 2). The result is consistent with the output of Mukhopadhyay and Yadav (1984). It was also noted that increasing the planting depth reduced the time required for inflorescence emergence. The maximum time (in days) (69.97) was required at a planting depth of 9 cm, while the minimum time (in days) (63.89) was recorded at 5 cm (Table 2). The effect of spacing and planting depth (combined) on inflorescence emergence was found as non statistically significant (Table 2). The longest time (71 days) was observed for the treatment combination of 25 cm × 10 cm spacing (closest) and 9 cm depth (deepest), while the shortest time (in days) (59.33) was recorded 25 cm × 20 cm spacing and 5 cm depth (in combination) (Table 2). Syamal et al. (1987) got the same trend.

Table 1. Impact of spacing and depth of planting on the vegetative growth of gladiolus. Plant height, number of leaves per plant and length of leaves were considered as vegetative growth marker of the plant for this experiment.

	Plant height (cm)				**Number of leaves per plant**					**Length of leaves (cm)**			**SEM**
	30 DAP	**45 DAP**	**60 DAP**	**75 DAP**	**30 DAP**	**45 DAP**	**60 DAP**	**75 DAP**	**30 DAP**	**45 DAP**	**60 DAP**	**75 DAP**	
Spacing													
25 cm x 10 cm	44.79	51.54	60.01	67.86	3.13	5.25	6.76	8.08	37.66	45.48	51.65	56.97	1.79
25 cm x 15 cm	46.15	53.75	62.15	70.6	3.38	5.54	7.06	8.67	39.39	47.24	52.88	57.55	1.14
25 cm x 20 cm	47.2	54.49	62.58	72.42	3.78	5.65	7.26	8.9	39.72	46.23	51.18	56.46	2.05
Significant level	**	NS	NS	**	**	**	**	**	NS	NS	NS	NS	
Depth of planting													
5 cm	45.28	53.73	62.33	70.29	3.42	5.47	7	8.56	42.3	48	51.49	56.46	1.38
7 cm	45.7	52.37	60.42	69.79	3.46	5.51	7.07	8.56	35.43	43.76	50.8	56.03	1.50
9 cm	47.17	53.69	61.99	70.8	3.42	5.47	7	8.53	39.04	47.2	53.43	58.49	1.31
Significant level	NS	NS	NS	**	NS	NS	NS	NS	**	**	NS	NS	

Values are the mean of 3 replicates for each of spacing and depth of planting. SEM was expressed as the mean value of SD for spacing and depth of planting separately. The values for all markers were counted in certain time period of days after planting (DAP). ** Significant at 1% level of probability, NS: Non-Significant.

- **Length of spikes**

The length of gladiolus spikes was significantly influenced by spacing, planting depth, and their combination. The longest spike (85.68 cm) was observed spacing of 25 cm × 20 cm which is the widest one by Syamal et al. (1987) while the shortest spike (74.41 cm) was at the closest spacing of 25 cm × 10 cm (Table 2). This finding is consistent to the results of Mollah et al. (1995) and Banker and Mukhopadhyay (1980). Regarding planting depth, the longest spike (82.56 cm) was found at a depth of 9 cm (deepest), while the shortest spike (76.61 cm) was recorded at 7 cm planting depth (Table 2). The widest spacing (25 cm × 20 cm) and deepest depth (9 cm) (in combination)produced the longest spike (89.67 cm), while the combination of the closest spacing (25 cm × 10 cm) and deepest depth (9 cm) produced the shortest spike (74.21 cm).

- **Number and weight of cormel per plant**

The number of cormels per plant was influenced significantly by both spacing and planting depth. It increased with wider spacing. The number of cormels (38.05) (maximum) was observed at the widest spacing of 25 cm × 20 cm, while the number (28.68) (minimum) was recorded at the spacing of 25 cm × 10 cm (closest) (Table 2). Wider spacing is responsible to reduce competition of plants to get sunlight and nutrients, which ultimately leads to a larger number of cormels per plant. This result is consistent with the findings of Mollah et al. (1995). Regarding planting depth, the experiment concluded that shallower planting depths resulted in the highest number of cormels per plant. The number of cormels (38.43) (maximum) was observed at a depth of 5 cm (shallowest), while the minimum number (29) was found at 9 cm (deepest) (Table 2). This finding aligns with the results of Banker and Mukhopadhyay (1980).

Table 2. Effect of spacing and planting depth on emerging inflorescence, spike length, cormel number and weight of gladiolus

	Days required for emergence of inflorescence	Length of spike (cm)	Number of cormel per Plant	Weigh of cormel per plant (gm)
Spacing				
25 cm x 10 cm	66.67 ± 3.15	74.41 ± 4.32	28.68 ± 1.43	32.20 ± 2.25
25 cm x 15 cm	65.22 ± 2.19	80.75 ± 5.14	33.29 ± 1.13	38.38 ± 2.68
25 cm x 20 cm	63.89 ± 4.03	85.68 ± 3.11	38.05 ± 1.17	44.39 ± 1.31
Significant level	**	**	**	**
Depth of planting				
5 cm	60.78 ± 2.46	81.68 ± 5.61	38.43 ± 2.09	45.71 ± 3.16
7 cm	65.33 ± 3.83	76.61 ± 5.47	32.60 ± 1.40	37.79 ± 1.66
9 cm	69.67 ± 3.21	82.56 ± 6.14	29.00 ± 1.17	31.46 ± 1.84
Significant level	**	**	**	**

Data were expressed as mean ± SD of 3 replicates for each treatment. The days required for plant emergence were counted when at least 50% of the plants had emerged in each replication. The length of the spike was measured at harvest time. *Indicates significance at the 1% level of probability (Mukhopadhyay, 1980). We found a significant effect of spacing and planting depth individually on the number of cormels produced per plant, their effect was not significant statistically. The maximum number of cormels per plant (43.23) was from the treatment combination of 25 cm × 20 cm spacing (widest) and 5 cm depth (shallowest), while the minimum number (24.16) was noted from the treatment combination of 25 cm × 10 cm spacing (closest) and 9 cm depth (deepest). A similarity was reported by Syamal et al. (1987).The weight of cormels per plant became changed significantly with both plant spacing, planting depth, and their combination. The cormel weight (44.39 g) (maximum) was recorded at the widest spacing of 25 cm × 20 cm, while the weight (32.20 g) (minimum) was at the closest spacing of 25 cm × 10 cm (Table 2). This result shows an alignment with the findings of Arora and Khanna (1987). The maximum cormel weight (45.71 g) was observed at a planting depth of 5 cm (shallowest), while the minimum weight (31.46 g) was recorded at 9 cm (deepest depth) (Table 2).

Effect of spacing and depth of planting on production of Gladiolus

- **Yield of spike (t/ha)**

Highly significant effect of spacing and planting depth on spike yield was found. Wide spacing gave a result in a smaller yield, as the number of plants (and consequently, the number of spikes) decreased with the increasing in spacing. The spike yield (11.40 t/ha) (highest) was at the closest spacing of 25 cm × 10 cm, while the yield (5.83 t/ha) (lowest) was at the widest spacing of 25 cm × 20 cm (Figure 2). This is consistent with the findings of Borrelli (1984). Regarding planting depth, the maximum spike yield (8.71 t/ha) was at a planting depth of 9 cm (deepest), while the yield (7.96 t/ha) (minimum) was at 7 cm depth (Figure 2). The spacing and planting depth (in combination) had no significant effect on spike yield (Figure 2). The yield (12.00 t/ha) (highest) was with the treatment combination of 25 cm × 10 cm spacing (closest) and 9 cm depth (deepest), while the yield (5.31 t/ha) (lowest) was from the combination of 25 cm × 20 cm spacing (widest) and 7 cm depth (intermediate). A similarity was reported by Syamal et al. (1987).

- **Yield of corm (t/ha)**

A significantly influence by plant spacing was on yield of corms. Yield increased by decreasing space , as closer spacing resulted in a better number of corms. The corm yield (7.99 t/ha) (maximum) was at the closest spacing of 25 cm × 10 cm, while yield (4.17 t/ha) (minimum) was recorded at the widest spacing of 25 cm × 20 cm (Table 5.A). This result is found to be consistent with the results of Rabbani and Azad (1996), Talia et al. (1986), Nilimesh and Roychowdhury (1989), and Borrelli (1984). Corm yield (5.91 t/ha) (maximum) was at a planting depth of 9 cm, while yield (5.75 t/ha) (minimum) was at 7 cm depth. However, non-significant effect was here (Figure 2). The effect of spacing and planting depth (combined) had a influence on corm yield that is statistically significant (Figure 2). The corm yield (8.29 t/ha) (highest) was with the treatment combination of 25 cm × 10 cm spacing (closest) and 5 cm depth (shallowest), while the yield (4.02 t/ha) (lowest) was from the combination of 25 cm × 20 cm spacing (widest) and 5 cm depth (shallowest).

Yield of cormel (t/ha)

Highly significant effect of spacing and planting depth on cormel yield was there. Wider spacing gave a lower yield, as the number of plants decreased with increasing space. The cormel yield (6.54 t/ha) (maximum) was at the spacing of 25 cm × 10 cm, while yield (3.52 t/ha) (minimum) was at the widest spacing of 25 cm × 20 cm (Table 5.A). This finding is reported as consistent to the findings of Rabbani and Azad (1996). Regarding planting depth, the cormel yield (5.75 t/ha) (maximum) was at a depth of 5 cm, while yield (3.94 t/ha) (minimum) was at 9 cm depth (Figure 2). The effect of spacing and planting depth (combined) also showed an impact on cormel yield that is statistically significant (Figure 2). The cormel yield (7.81 t/ha) (highest) was from the treatment combination of 25 cm × 10 cm spacing (closest) and 5 cm depth (shallowest), while the yield (2.94 t/ha) (lowest) was from the combination of 25 cm × 20 cm spacing (widest) and 9 cm depth (deepest).

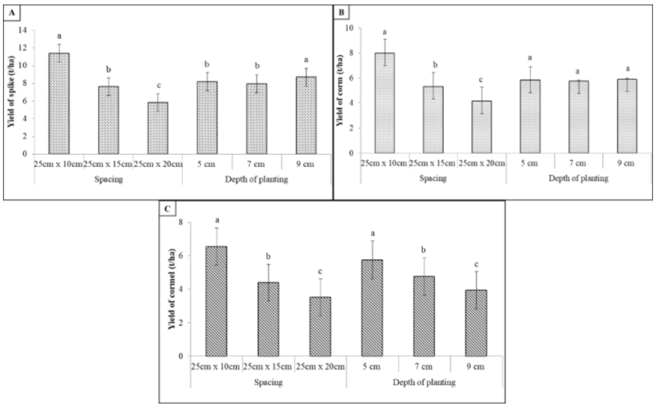

Figure 2. Impact of spacing and depth of planting on the yield of gladiolus.

Conclusion

The tallest plants got from the widest spacing. this is also responsible for the highest number of leaves, the tallest spikes, and the maximum weight of individual corms and cormels per plant. However, the highest yield of spikes, cormels and corms was from the closest spacing. In same way, the shallowest planting depth ensured the maximum weight and number of cormels, while the deepest depth was for the tallest and heaviest spikes. The treatment in combination of the closest spacing and shallowest depth confirmed a benefit-cost ratio of 2.33.

References

1. Bankar, J. G., & Mukhopadhyay, A. (1980). Effects of corm size, depth of planting and spacing on the production of flowers and corms in gladiolus. *Indian Journal of Horticulture*, *37*(4), 403-408.

2. Borrelli, A. (1984). Planting density and nitrogen fertilizing in the cultivation of gladioli in summer and autumn.

3. Bose,T. K and Yadav, L.P. 1989. Commercial Flowers. Naya Prokash, Calcutta- 7, India p. 267.

4. Deswal, K. S., Patil, V. K., & Anserwadekar, K. W. (1983). Nutritional and plant population studies in gladiolus.

5. Gowda, J. V. N. (1987). Interaction effect of corm size and spacing on growth and flower production in gladiolus cv. Snow Prince.

6. KONOSHIMA, H. (1980). Effects of planting depth and soil covering at different stages on the dormancy and weight of gladiolus corms. *Journal of the Japanese Society for Horticultural Science*, *49*(3), 403-408.

7. Mollah, M. S., Islam, S., Rafiuddin, M., Choudhury, S. S., & Saha, S. R. (1995). Effect of cormel size and spacing on growth and yield of flower and corm of gladiolus. *Bangladesh Hort*, *23*(1&2), 67-71.

8. Mukhopadhyay, T. P., & Yadav, L. P. (1984). Effect of corm size and spacing on growth, flowering and corm production in gladiolus.

9. Sheikh Maniruzzaman, M. G. R., Akter, T., Barua, R., Brua, J. L., & Haque, M. M. (2017). Effects of Cut Corm and Plant Spacing on Yield and Quality of Gladiolus (Gladiolus grandiflorus L.).

10. Nilimesh Roychowdhury, N. R. (1989). Effect of plant spacing and growth regulators on growth and flower yield of gladiolus grown under polythene tunnel.

11. Rabbani, M. G., & Azad, A. K. (1996). Effect of corm size and spacing on the growth and flower production of gladiolus. *Bangladesh Hortic*, *24*(1&2), 1-6.

12. Syamal, M.M., Rajput, C.B.S. and Singh, S.P. 1987. Effect of corm size and planting distance and depth of planting on the growth and flowering of gladiolus. Res. Dev. Rep. 1987. Banaras Hindu Univ. Banaras, India. pp. 10-12.

13. Talia, M. C., & Traversa, E. (1986). First results from a study of the effect of planting density on increasing the size of gladiolus corms.

14. Yadav, S. K., & Tyagi, A. K. (2007). Effect of corm size and spacing on growth and flowering of gladiolus cv. Sylvia.