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Effects of Cut Corm and Plant Spacing on Yield and Quality of Gladiolus (*Gladiolus grandiflorus* L.)

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Abstract: A field experiment was the effects of different cut corm and plant spacing on growth, flowering, corm and cornel production of gladiolus. The highest yield of flowers (2.92 lac/ 3650 USD) was recorded from the treatment combination of 1/2 cut corm and closer spacing (25 x 15 cm). The highest yields of corm (32.33 t/ha) was obtained from the treatment combination of whole corm and closest spacing (25 x 10 cm) and highest yields of cormel (1.13 t/ha) from the treatment combination of 1/2 cut corm and the closest (25 x 10 cm) spacing. Significant interaction effects were observed between cut corm and plant spacing for 80% emergence and number of florets per spike and found to be the best for the production of good quality spike, corm and cormel of gladiolus.

Key words: Gladiolus · Cut Corm · Plant Spacing · Yield and Quality

INTRODUCTION

Gladiolus *(Gladiolus grandiflorus* L.*)* is one of the most important cut flowers in the flower industry. It occupies fourth place in international cut flower trade [1]. It belongs to the family Iridaceae. It is a very popular and an important ornamental flowering plant of the world. The genus Gladiolus comprises 260 species. The development of modern gladiolus started in eighteenth century. The modern gladioli are mostly hybrids. Different species such as *G. auranticaus, G. blandas, G. cardinalis, G. cruentus, G. dracociphalus* and *G. tritis* var. *concolor* were used to develop the hybrid cultivars of gladiolus [2]. The name gladiolus was derived from Latin word gladius because of its sword like leaves. Gladiolus is frequently used as cutflower in different social and religious ceremonies. It is also useful for beds, herbaceous border and does quite well in pots. As a landscape plant, its spikes are most popular in flower arrangements and for preparing high class bouquets. The aesthetic value of gladiolus in the daily life is increasing with the advancement of civilization. It gained popularity in many parts of the world due to its unsurpassed beauty and economic value. As cut flower, it is next to tulip in Holland in commercial importance [3]. It has attractive spikes having florets of huge forms, dazzling colours, varying sizes and long vase

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life. But its commercial production is still at the initial stage due to lack of information regarding its cultivation technology. Some farmers of Southwestern region of Bangladesh especially in greater Jessore district are growing gladiolus on commercial basis.

There is year round demand of gladiolus spikes and its demand is increasing day by day in Bangladesh. It is traditionally propagated by corms and cormels. Different factors such as cut corm, size of corm and cormel, spacing, planting time and fertilizer management influence the production and quality of gladiolus flower as well as corm and cormel [4, 5, 6]. Cut corm influences vegetative growth, flower production, vase life of flower and corm and cormel yields. As cut corm produces flowers two times higher than single corm; the production cost becomes half. Beside this, the production of corm and cormel and quality flower is also affected by variation in spacing. Yadav and Tyagi [7] recommended the largest cut corm that produced the highest number of leaves per plant, number of spikes per plant, spike length, number of florets per spike, number of corms per plant and diameter of new corm. The widest spacing (25 cm x 30 cm) resulted in the greatest plant height, number of leaves per plant, number of spikes per plant, spike length, number of florets per spike, number of cormels per plant and diameter of new corm. Rabbani and Azad [8] suggested large corm (30 g) and spacing of 20 cm x 20 cm for the production of quality flowers of gladiolus at Bangladesh Agricultural University, Mymensingh. Considering of the above facts, the present study was, therefore, undertaken with the following objectives: To study the growth, flowering and yield of gladiolus produced from cut corm; to study the effect of plant spacing on growth, flowering and yield of gladiolus; and to find out the optimum cut corm and plant spacing.

MATERIALS AND METHODS

The present study was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh to investigate the effect of cut cormel weight and plant spacing on growth, flowering, corm and cormel production of gladiolus. The locality, where the experiment was carried out has three distinct seasons *viz.* the winter or dry season extending from October to January, the pre-monsoon period or hot season from February to March and the monsoon or rainy season from April to May. The experimental site was a medium high land having proper drainage and irrigation facilities. The soil was sandy loam in texture with pH 6.85. The land was belonging to the Brahmaputra Flood Plain.

There were two factors in this experiment. The factors with their levels are-Factor A: Cut corme weight C_1(whole corm) = 15±2g, C_2 (1/2 cut corm) = 15 ± 2 g, C_3 (1/3 cut corm) = 15 ± 2 g, C_4 (1/4 cut corm)= 15 ± 2 g. Factor B: Plant spacing S_1 = 25 cm X 10 cm, S_2 = 25 cm x 15 cm, S_3 = 25 cm X 20 cm, S_4 = 25 cm X 25 cm. There were altogether 16 treatment combinations in this experiment. The corms of Indian cultivars "Red beauty" were collected from Gadkhali, Jhikorgacha, Jessore, Bangladesh and used in the present study. The land of experimental plot was opened, thoroughly prepared by several ploughings and cross ploughings with power tiller followed by laddering to obtain a good tilth. The weeds were collected before final land preparation. The basal doses of manures and fertilizers were applied during final land preparation.

The two-factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each block was divided into 16 plots where 16 treatments were allotted at random. Thus, there were 48 (16 x 3) unit plots in the experiment. The size of a unit plot was 3.0 m x 1.0 m. The distance between the blocks was 0.5 m and between the adjacent plots was 0.3m. The crop was fertilized with the following doses of manure and fertilizers. Cowdung-3 kg, Urea-60g, Triple Superphosphate (TSP)-67.5g Muriate of potash (MP)-57g per plot (Recommended dose Cowdung-10 ton, Urea-200kg, Triple Superphosphate (TSP)-225kg, Muriate of potash (MOP)-190kg ha^{-1}). The entire amount of cowdung was applied during general land preparation and entire quantity of Triple Super Phosphate was applied during final land preparation. Urea and MP were applied as side dressing in two equal installments after 25 and 50 days of planting. Before planting, corms were cut into several pieces viz. as treatments, a number of corms were cut into two pieces, another number cut into three pieces, the other number cut into four pieces and a number of corm remained as whole. Then the planting materials were kept in a air dried place for two days to avoid rotting of corm in the field and the corms were planted at a depth of about 6 cm in furrows.

The spikes of gladiolus were harvested at the tight bud stage and when three basal flower buds showed color so that these may easily open in indoors one by one [1]. Corms and cormels were harvested when 25 percent of cormels had become brown and the leaves also started yellowing. Data were collected from ten plants selected at random from the middle rows of each unit plot. Data were collected in respect of the following parameters. Days required for 80% emergence, Plant height, Length and breadth of leaves, Number of leaves per plant at harvest, Days required for first spike initiation, Spike length at harvest, Rachis length at harvest, Number of florets per spike, Number of flowers per plot, Weight of corm per plant, Diameter of corm, Weight of corms per plot, Number of cormels per plant, Weight of cormels per plant, Diameter of cormel, Weight of cormels per plot, Yield of corms per ha (t), Yield of cormels per ha (t).

RESULTS AND DISCUSSION

The present study was conducted to investigate the effect of cut corm and plant spacing on growth, flowering, corm and cormel production of gladiolus .The results of the study are presented and discussed in this chapter.

Plant Height: The data on plant height were recorded at different stages of growth i.e. 25, 50 and 75 days after planting (DAP). Cut corms were found to have significant effect on the height of plant (Table 1). The results revealed that the highest plant height was obtained from 1/2 cut corm weight (31.05cm) and the lowest plant height was recorded from 1/4 cut corm weight (23.80cm) at 25days after planting (DAP). At 50 DAP the highest plant height was obtained from 1/2 cut corm weight (61.27cm) and lowest plant height was found in 1/3 cut corm weight (42.23cm). Again at 75 DAP the highest plant height was obtained from 1/2 cut corm (67.06cm) and lowest was recorded in 1/4 cut corm (51.42 cm) (Table 1). [9] while working with different size grades of planting material on flowering and multiplication of gladiolus variety White Oak reported similar result. Different plant spacing significantly influenced the plant height of the crop and plant height was increased gradually from wider spacing to the closer spacing (Table 1). The highest plant height (29.02 cm, 53.32 cm and 63.33 cm) was obtained from plant spacing 25cm x 10 cm at different stages of growth i.e. 25, 50 and 75 days after planting (DAP) and the lowest plant height (29.09 cm, 48.00 cm and 55.21 cm) was recorded from widest spacing (25 cm x 25 cm) at different stages of growth i.e. 25, 50 and 75 days after planting (DAP) (Table 1). Combined effect of cut corm used and plant spacing on the plant height was found to be significant at all dates after planting but their interaction effect was non-significant (Table 2). It was found that the treatment combination of 1/2 cut corm (15 ± 2 g) and 25 cm x 10 cm plant spacing produced tallest plant at 75 DAP (73.68 cm) while it was minimum (47.12 cm) in 1/4 cut corm weight (15 ± 2 g) and plant spacing (25 cm x 25 cm) (Table 2).

Number of Leaves Plant^{-1} at Harvest: The leaves per plant were counted at harvest time. There was a significant variation in the number of leaves per plant at harvest due to different cut corms used (Table 3). The maximum number of leaves (7.42) was produced by the 1/2 cut corm (15 ± 2 g) at harvest, while it was minimum (6.29) in 1/4 cut corm (Table 1). [10] reported similar result. Different plant spacing significantly influenced the plant leaves of the crop and plant leaves were increased gradually from closer spacing to the wider spacing (Table 3). The maximum number of leaves (7.11) was produced by the wider plant spacing (25 cm x 20 cm) at harvest, while it was minimum (6.31) in closest plant spacing (25 cm x 25 cm) (Table. 1). Combined effects of different cut corm and plant spacing on number of leaves per plant were statistically significant but their interaction was non-significant (Table 2). It was found that maximum number of leaves (7.58) was produced in case of 1/2 cut corm (15± 2 g) and 25 cm x 25 cm plant spacing. The minimum number of leaves (5.58) was produced in case of 1/3 cut corm (15 ± 2 g) and 25 cm x 10cm plant spacing (Table 2).

Length of Leaf at Harvest: The length of leaves per plant was counted at harvest. There was significant variation in the length of leaves per plant at harvest due to different cut corm (Table 3). The highest length of leaves (49.78cm) was produced by the 1/2 cut corm (15 ± 2 g) at harvest, while it was the lowest (40.85cm) in 1/4 cut corm (Table 1). [10] reported similar result. Different plant spacing significantly influenced the length of leaves per plant of the crop and length of leaves per plant was increased gradually from closer spacing to the wider spacing (Table 3). The highest length of leaves (48.60 cm) was produced by the widest plant spacing at harvest, while it was the lowest (41.67cm) in closest plant spacing (Table 1). Combined effects of different cut corms and plant spacing on length of leaves per plant were statistically significant but their interaction effect was non-significant (Table 2). It was found that the highest length of leaves (52.78) was produced in case of 1/2 cut corm (15± 2 g) and 25 cm x 25 cm plant spacing. The lowest length of leaves (38.57 cm) was produced in case of 1/4 cut corm (15 ± 2 g) and 25 cm x 10cm plant spacing.

Breadth of Leaf at Harvest: The breadth of leaves per plant was counted at harvest. There was significant variation in the breadth of leaves per plant at harvest due to different cut corm (Table 1). The highest breadth of leaves (3.93 cm) was produced by the 1/2 cut corm (15 ± 2 g) at harvest, while it was the lowest (3.50 cm) in 1/4 cut corm (Fig. 1). [10] reported similar result. Different plant spacing significantly influenced the breadth of leaves per plant of the crop and breadth of leaves per

Table 1: Effect of cut corm and plant spacing on plant height, leaf characters and reproductive characters of gladiolus

Treatment Number of cut (Each cut weight 15g ± 2)	Plant height at 25 DAP	50 DAP	75 DAP	Number of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Rachis length (cm)	Spike length (cm)	Number of floret spike^{-1}	Number of flowers plot^{-1}
Whole corm	27.56	54.74	61.61	7.29	49.65	3.6	40.53	76.04	10.5	68.92
2 cut corm	31.05	61.27	67.06	7.42	49.78	3.93	42.38	76.85	11.01	72.25
3 cut corm	26.1	42.23	57.33	6.61	41.41	3.51	38.76	68.55	9.77	31.58
4 cut corm	23.8	45.25	51.42	6.29	40.85	3.5	33.24	60.18	8.94	28.17
Level of sig.	**	**	**	**	**	**	**	**	**	**
LSD (0.05)	1.34	1.87	2.09	0.25	1.28	0.046	1.24	1.9	0.35	2.03
LSD (0.01)	1.8	2.49	2.8	0.34	1.72	0.054	1.66	2.55	0.46	2.72
Spacing										
25 cm × 10 cm	29.02	53.32	63.33	6.31	41.67	3.53	36.72	67.67	9.47	62.25
25 cm × 15 cm	28.16	52.2	60.27	6.81	45.27	3.62	37.77	69.85	9.91	57.41
25 cm × 20 cm	26.23	49.98	58.61	7.11	46.15	3.65	39.23	71.69	10.26	43.83
25 cm × 25 cm	25.09	48	55.21	7.38	48.6	3.74	41.2	72.4	10.57	37.42
Level of sig.	**	**	**	**	**	**	**	**	**	**
LSD (0.05)	1.55	2.16	2.42	0.29	1.48	0.053	1.43	2.19	0.4	2.35
LSD (0.01)	2.06	2.88	3.24	0.39	1.98	0.07	1.92	2.94	0.53	3.14
CV (%)	5.93	4.4	4.23	4.36	3.39	1.39	3.84	3.24	4.12	4.85

*, ** indicate significant at 5% and 1% level of probability, respectively.

Table 2: Combined effect of cut corm and plant spacing on plant height, leaf characters and reproductive characters of gladiolus

Interaction (Corm cut level × plant spacing)	Plant height at 25 DAP	50 DAP	75 DAP	Number of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)	Rachis length (cm)	Spike length (cm)	Number of floret spike^{-1}	Number of flowers plot^{-1}
C_1S_1	29.32	57.25	63.97	6.77	48.01	3.54	39.06	73.88	9.74	80.33
C_1S_2	28.88	56.04	62.08	7.33	48.45	3.57	39.62	75.65	10.61	77.33
C_1S_3	26.82	53.72	61.74	7.47	49.37	3.60	39.77	76.82	10.72	61.67
C_1S_4	25.22	51.95	58.66	7.58	52.78	3.70	43.68	77.81	10.94	56.33
C_2S_1	32.47	64.64	73.68	7.00	47.86	3.75	41.40	74.37	10.44	83.33
C_2S_2	31.88	64	67.38	7.56	49	3.92	41.33	76.07	10.61	87.67
C_2S_3	30.53	59.82	65.13	7.57	49.86	3.95	41.73	78.18	11.42	66.33
C_2S_4	29.31	56.64	62.04	7.58	52.39	4.08	45.06	78.8	11.56	51.67
C_3S_1	29.81	44.55	62.55	5.58	38.57	3.43	35.96	65.92	9.47	45.33
C_3S_2	28.18	42.81	58.61	6.47	40.99	3.49	36.62	67.76	9.49	34.33
C_3S_3	23.93	40.9	55.22	6.83	41.12	3.54	41.08	70.07	10	25.33
C_3S_4	22.48	40.67	52.94	7.55	44.97	3.6	41.39	70.45	10.11	21.33
C_4S_1	24.5	46.83	53.13	5.89	32.24	3.41	30.44	56.5	8.22	40
C_4S_2	23.7	45.95	53	5.89	42.65	3.49	33.51	59.94	8.94	30.33
C_4S_3	23.67	45.47	52.36	6.55	44.26	3.51	34.34	61.7	8.91	22
C_4S_4	23.34	42.75	47.19	6.82	44.26	3.58	34.68	62.56	9.67	20.33
Level of sig.	*	*	*	*	**	*	*	*	*	**
LSD (0.05)	2.68	3.73	4.19	0.5	2.57	0.091	2.48	3.8	0.69	4.06
LSD (0.01)	3.59	5	5.61	0.67	3.44	0.122	3.31	8.09	2.92	5.44
CV (%)	5.93	4.4	4.23	4.36	3.39	1.39	3.84	3.24	4.12	4.85

*, ** indicate significant at 5% and 1% level of probability, respectively

C1 = Whole corm of 15 g ± 2; C2 =1/2 cut corm, each cut 15 g ± 2;

C3 = 1/3 cut corm, each of 15 g ± 2 and C4 = 1/4 cut corm, each of 15 g ± 2;

S1 = Plant spacing of 25 cm × 10 cm; S2 = Plant spacing of 25 cm × 15 cm

S3 = Plant spacing of 25 cm × 20 cm and S4 = Plant spacing of 25 cm × 25 cm

plant was increased gradually from closer spacing to the wider spacing (Table 1). The highest breadth of leaves (3.74 cm) was produced by the widest plant spacing at harvest, while it was the lowest (3.53 cm) in closest plant spacing at harvest (Table 1). Combined effects of different cut corms and plant spacing on breadth of leaves per plants were statistically significant but their interaction effect was non-significant (Table 2). It was found that the highest breadth of leaves (4.08 cm) was produced in case of 1/2 cut corm (15± 2 g) and 25 cm x 25 cm plant spacing. The lowest breadth of leaves (3.41 cm) was produced in case of 1/4 cut corm (15 ± 2 g) and 25 cm x 10cm plant spacing (Table 2).

Table 3: Effect of cut corm and plant spacing on yield component character of gladiolus

Treatment ---------------- Number of cut (Each cormel weight 15 ± 2g)	Corm diameter (cm)	Corm weight plant^{-1} (g)	Corm weight plot^{-1} (g)	Number of cormel plant^{-1}	Cormel diameter (cm)	Cormel weight plant^{-1} (g)	Cormel weight plot^{-1} (g)	Yield of flower (lac/ha)	Yield of corm (t/ha)	Yield of cormel (t/ha)
Whole corm	5.29	75.9	5.64	27.09	0.99	9.78	266	2.29	23.258	0.873
2 cut corm	5.31	78.75	5.55	29.42	1.16	9.3	315.6	2.405	24.515	1.047
3 cut corm	4.24	55.39	4.03	23.43	0.99	8.93	217.9	1.05	11.19	0.725
4 cut corm	3.71	47.41	3.15	21.55	0.96	8.8	210.4	0.935	12.792	0.69
Level of sig.	**	**	**	**	**	**	**	**	**	**
LSD (0.05)	0.22	1.98	0.37	1.5	0.026	0.23	11.05	2.268	19.98	0.4709
LSD (0.01)	0.29	2.64	0.5	2.01	0.035	0.31	14.87	3.053	26.9	0.6341
Spacing										
25 cm × 10 cm	4.46	58.67	5.28	24.12	0.99	8.61	279.5	2.07	23.08	0.94
25 cm × 15 cm	4.6	62.21	5.51	25.02	1	8.99	277.5	1.91	18.985	0.885
25 cm × 20 cm	4.76	67.39	4.21	25.72	1.03	9.29	239.1	1.457	17.05	0.8
25 cm × 25 cm	4.72	69.2	3.37	26.63	1.07	9.93	213.7	1.243	12.64	0.71
Level of sig.	*	**	**	*	**	**	**	**	**	**
LSD (0.05)	0.25	2.28	0.43	1.74	0.03	0.26	12.76	1.113	12.52	0.29
LSD (0.01)	0.34	3.06	0.57	2.32	0.04	0.35	17.18	1.499	16.86	0.3905
CV (%)	5.63	3.68	9.68	7.11	3.07	2.98	5.25	12.26	2.43	7.04

*, ** indicate significant at 5% and 1% level of probability, respectively

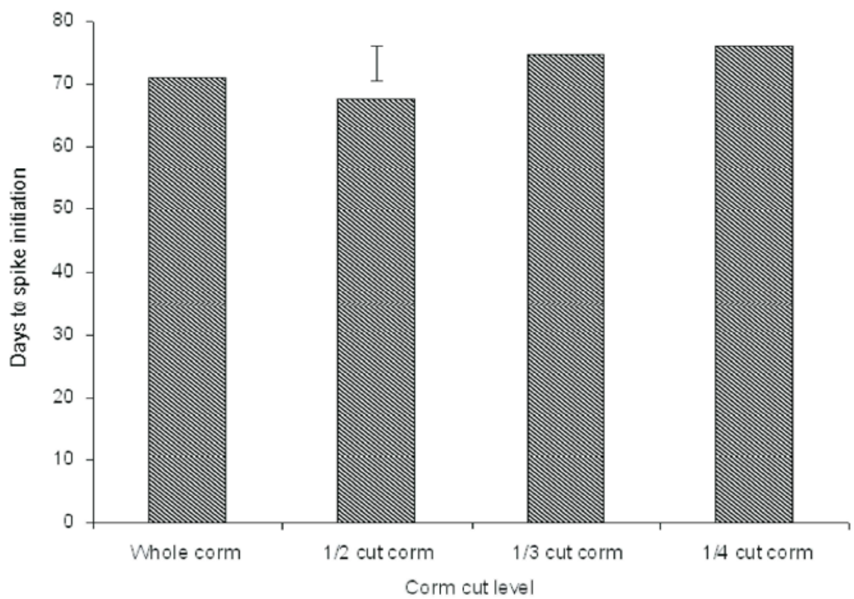

Fig. 1: Effect of cut corm on days to spike initiation in gladiolus. Vertical bar represents LSD (0.05)

Rachis Length at Harvest: The rachis length was significantly influenced by different cut corm (Table 1). The highest rachis length (42.38 cm) was produced from 1/2 cut corm while it was the minimum (33.24 cm) with 1/4 cut corm (Table 1). [5] reported the similar results. The plant spacing had significant effect on the rachis length (Table 1). The rachis length varied from 41.20 to 36.72 cm. The highest rachis length (41.20 cm) was obtained from the widest spacing of 25 cm x 25 cm (Table 5). On the other hand, the lowest rachis length (36.72 cm) was recorded from the plants grown under the closest spacing (25 cm x 10 cm). This might be due to more space and resources such as water, light, nutrients etc. are available in wider spacing. Combined effects of cut corm and plant spacing on rachis length at harvest were statistically significant but their interaction effect was non-significant (Table 2). It was found that the highest rachis length (45.06 cm) was produced in case of 1/2 cut corm (45 ± 2 g) and the widest plant spacing (25 cm x 25 cm) while the lowest (30.44 cm) was in case of 1/4 cut corm size (15 ± 2 g) and narrowest (25 x 10 cm) plant spacing (Table 2).

Spike Length at Harvest: The effect of different cut corms on the spike length at harvest was found to be significant. The tallest spike length (76.85 cm) was recorded with 1/2 cut corm size (15 ± 2 g) while it was the shortest (33.24 cm) with the 1/4 cut corm size (15 ± 2 g) (Table 1). Similar results i.e. the increase in spike length due to the use of large corm was recorded by [11]. The spike length was significantly influenced by different planting distance. Plants grown under wider spacing (25 cm x 25 cm) produced the longest spike (72.40 cm). On the other hand, the length of spike was found to be the shortest (67.67 cm) from closer spacing of 25 cm x 10 cm (Table 1). The increased length of spike from wider spacing was probably due to less competition among the plants for light and nutrients etc. Combined effect of cut corm and plant spacing on spike length at harvest was statistically significant but their interaction effect was non-significant (Table 2). It was found that the maximum spike length (78.80 cm) was produced in case of 1/2 cut corm size (15 ± 2 g) and the widest plant spacing (25 cm x 25 cm) while it was the minimum (56.50 cm) in case of 1/4 corm (15 ± 2 g) and 25 cm x 10 cm plant spacing.

Number of Florets Spike^{-1}: There was a significant variation among cut corms in respect of number of florets per spike. The maximum number of florets per spike (11.01) was found with (15 ± 2 g) 1/2 cut corm size where as the minimum (8.94) was with (15 ± 2 g) 1/4 cut corm size (Table 1). Singh [12] reported the maximum number of florets per spike with large corm size. The effect of different plant spacing on number of florets per spike was significant (Table 1) which varied from 9.47 to 10.57. The maximum number of florets per spike was obtained from the widest spacing (25 cm x 25 cm) and the minimum was under the closest spacing (25 x 10 cm).This might be due to less competition among the plants grown under the widest spacing for light, nutrient, water etc. Similar result was also reported by [13]. Combined effect of cut corm and plant spacing on number of florets per spike was significant (Table 2). The 1/2 cut corm size (15 ± 2 g) and the widest spacing (25 cm x 25 cm) produced maximum number (11.56) of florets per spike while it was minimum (8.22) with 1/4 cut corm size (15 ± 2 g) and the closest spacing (25 cm x 10 cm) (Table 2). [14] observed that maximum number of florets per spike with the treatment combination of largest corm size and the widest plant spacing.

Number of Flowers Plot^{-1}: There was significant variation among cut corms in respect of number of flowers per plot. The maximum number of flowers per plot (72.25) was found with (15 ± 2 g) 1/2 cut corm size where as the minimum (28.17) was with (15 ± 2 g) 1/4 cut corm size (Table 1). Singh [12] reported the maximum number of flowers per plot with large corm size. The effect of different plant spacing on number of flowers per plot was significant (Table 1) which varied from 62.25 to 37.42. The maximum number of flowers per plot was obtained from the closest spacing (25 cm x 10 cm) and the minimum was under the widest spacing (25 cm x 25 cm). Similar result was also reported by [13]. Combined effect of cut corm and plant spacing on number of flowers per plot was significant (Table 2). The 1/2 cut corm size (15 ± 2 g) and wider spacing (25 cm x 15 cm) produced maximum number (87.67) of flower per plot while it was minimum (20.33) with 1/4 cut corm size (15 ± 2 g) and the widest spacing of (25 cm x 25 cm) (Table 2). [14] observed that maximum number of flowers per plot with the treatment combination of the largest corm size and the widest plant spacing.

Days for Spike Initiation: The effect of cut corm on spike initiation was significant (Fig. 1). It was found that the longest time (76.01 days) was required by 1/4 cut corm to initiate spike followed by 1/3 cut corm (74.78 days). The lowest time (67.08 days) required for spike initiation was found in 1/2 cut corm which was statistically similar to whole corm (71.11 days). The effect of plant spacing on the time required for spike initiation was significant (Fig. 2). Days to spike initiation decreased with increased plant spacing. The highest time was required in the plants grown at the closest spacing (75.10 days) followed by next closer spacing (74.49 days). The lowest time required to spike initiation was found in the highest spacing (69.35 days) which was statistically similar to higher spacing (70.65 days). Combined effect of different cut corm and plant spacing on the time required for spike initiation was statistically significant but their interaction effect was non-significant. It was found that the highest time for spike initiation (76.00 days) was observed in case of 1/3 cut corm (15± 2 g) and closest (25 cm x 10 cm) plant spacing. The lowest time to spike initiation (63.47 days) was founded in case of 1/2 cut corm weight (15 ± 2 g) and 25 cm x 20cm plant spacing (Fig. 3).

Diameter of Corm: There was significant effect of different cut corm on the diameter of corm (Table 3). It was varied from 3.71 to 5.31 cm in diameter. Maximum diameter of corm (5.31 cm) was obtained from 1/2 cut corm and the minimum diameter of corm (3.71cm) was found from 1/4 cut corm. The results of the present experiment in respect of diameter of corm agree with the findings of [4, 9, 15], who reported that the plant from large corm produced larger sized corm. The diameter of corm varied significantly among the plant spacing (Table 3). The highest diameter

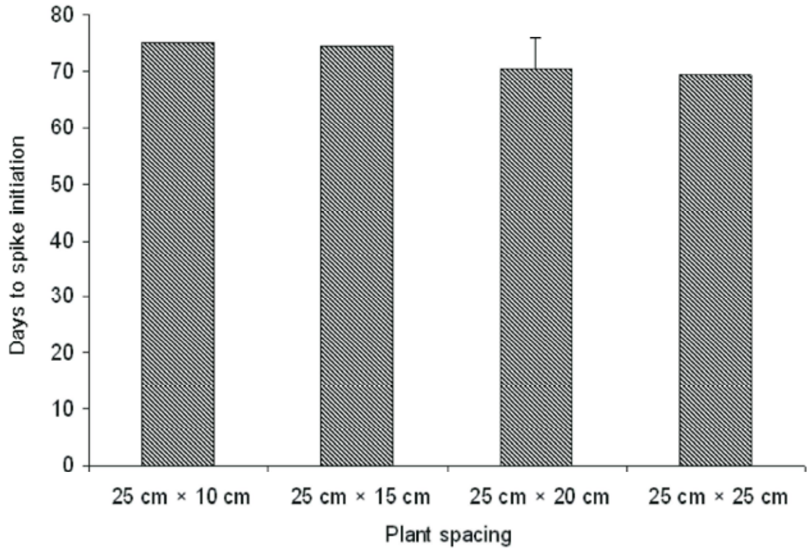

Fig. 2: Effect of plant spacing on days to spike initiation in gladiolus. Vertical bar represent LSD (0.05)

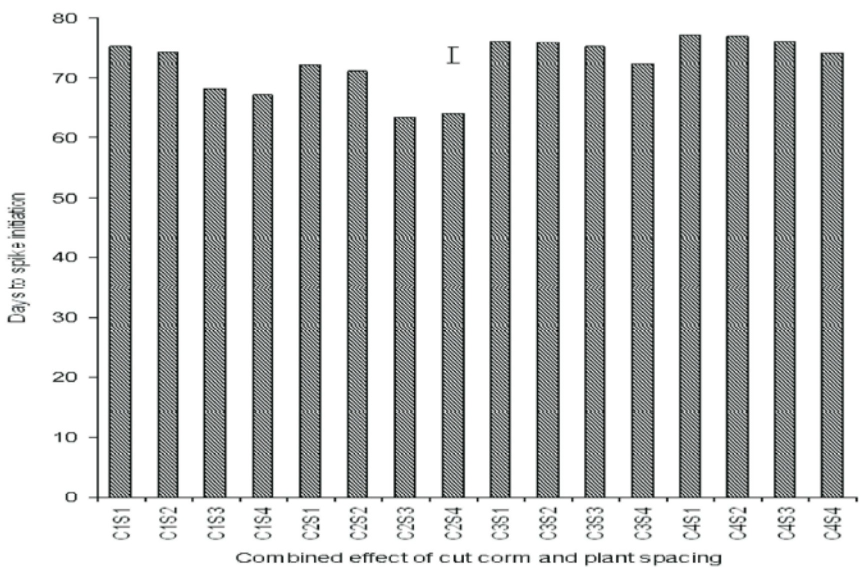

Fig. 3: Combined effect of cut corms and plant spacing on days to spike initiation in gladiolus. Vertical bar represents LSD (0.05)

C1 = Whole corm of 15 g ± 2; C2 =1/2 cut corm, each cut 15 g ± 2;
C3 = 1/3 cut corm, each of 15 g ± 2 and C4 = 1/4 cut corm, each of 15 g ± 2;
S1 = Plant spacing of 25 cm × 10 cm; S2 = Plant spacing of 25 cm × 15 cm
S3 = Plant spacing of 25 cm × 20 cm and S4 = Plant spacing of 25 cm × 25 cm

of corm (4.76 cm) was obtained from wider plant spacing (25 x 20 cm) and lowest diameter of corm (4.46 cm) was recorded from the closest plant spacing (25 x 10 cm). This might be due to more availability of space and resources such as nutrients, water, light etc. in wider plant spacing which resulted in better growth and development of corm per plant. The present findings are in agreement with the results reported by [16] where closer spacing reduced the average weight of corms. Combined effect of cut corm and plant spacing was found to be significant in respect of diameter of corm but their interaction effect was non-significant (Table 4). The maximum diameter of corm

(5.44 cm) was recorded from the treatment combination of whole corm size (15 ± 2 g) and wider plant spacing (25 cm x 25 cm) and minimum (3.55cm) was obtained from the treatment combination of 1/4 cut corm size (15 ± 2 g) and the closest spacing (25 cm x 10 cm) (Table 4).

Weight of Corm Plant^{-1}: The effect of different cut corms on weight of corm per plant was significant (Table 3). It was varied from 47.41 to 78.75 g. The plant from 1/2 cut corm produced the maximum weight of corm. On the other hand, the plant from 1/4 cut corm produced the minimum weight of corm. The possible reason of such result is that the 1/2 cut corm had more stored food for the development of healthy plant. [17] reported similar result. The weight of corm per plant varied significantly among the plant spacing (Table 3). The highest weight of corm per plant (69.20 g) was obtained from the widest plant spacing (25 cm x 25 cm) and the lowest weight of corm (58.67 g) was recorded from the closest plant spacing (25 cm x 10 cm). This might be due to more availability of space and resources such as nutrients, water, light etc. in wider plant spacing which resulted in better growth and development of corm per plant. The present findings are in agreement with the results reported by [16] where closer spacing reduced the average weight of corms. Combined effect of cut corm and plant spacing was found significant in respect of corm weight per plant but their interaction effect was non- significant (Table 4). The maximum weight of corm per plant (83.75 g) was given by 1/2 cut corm size (15 ± 2 g) with the widest plant spacing (25 cm x 25 cm) while minimum weight (44.44 g) was recorded in case of 1/4 cut corm size (15 ± 2 g) with the closest plant spacing (25 cm x 10 cm).

Weight of Corms Plot^{-1}: There was significant effect of different cut corms on weight of corms per plot (Table 3). Maximum corm weight per plot (5.64 kg) was obtained from planting whole corm size while minimum corm weight (3.15 kg) was given by 1/4 cut corm size (Table 3). There was not significant variation among the different plant spacing in weight of corm per plot (Table 3). Combined effect of cut corm and plant spacing was found significant in weight of corms per plot and but their interaction effect was non-significant (Table 4). The maximum corm weight per plot (7.00 kg) was recorded from the whole corm size (15 ± 2 g) with the closest spacing (25 cm x 10 cm) while the minimum (2.43 kg) was recorded in case of 1/4 cut corm size (15 ± 2 g) with the widest (25 cm x 25 cm) spacing of plant.

Number of Cormels Plant^{-1}: There was significant variation in number of cormels per plant at harvest to due to the effect of different cut corms. The maximum number of cormels per plant (29.42) was obtained from 1/2 cut corm size (15 ± 2 g) and the minimum number of cormels per plant (21.55) was recorded from 1/4 cut corm size (15 ± 2 g) (Table 3). This might be due to the fact that the more cut corm took the longest time for the harvest of spike which ultimately got more time and failed to form greater number of cormel production [12] reported the similar results. Plant spacing had significant influence on the number of cormels per plant (Table 3). The maximum number of cormels per plant (26.63) was obtained from the widest plant spacing (25 cm x 25 cm). But minimum number of cormels per plant (24.12) was found from the closest plant spacing (25 cm x 10 cm). Widest plant spacing (25 cm x 25 cm) provided the plant with sufficient nutrients, moisture and other essentials conditions for proper growth and development which ultimately increased the number of cormels per plant. The present findings are similar to the results as reported by [14] where the number of cormels per plant was significantly increased with increasing plant spacing. Combined effect of plant spacing and cut corm in respect of number of cormels per plant was statistically significant but their interaction effect was non-significant (Table 4). The maximum number of cormels per plant (30.39) was produced with 1/2 cut corm size (15 ± 2 g) and the widest spacing (25 x 25 cm) while the minimum (20.22) was recorded in case of 1/4 cut corm size (15 ± 2 g) and narrowest (25 x 10 cm) plant spacing.

Diameter of Cormel: There was significant effect of different cut corms on the diameter of cormel (Table 3). It was varied from 0.96 to 1.16 cm in diameter. Maximum diameter of cormel (1.16 cm) was obtained from 1/2 cut corm and the minimum diameter of corm (0.96) was found from 1/4 cut corm. The results of the present experiment in respect of diameter of cormel agree with the findings of [4, 9, 15], who reported that the plant from large corm produced larger sized cormel. The diameter of cormel varied significantly among the plant spacing (Table 3). The highest diameter of cormel (1.07 cm) was obtained from the wide plant spacing (25 x 25 cm) and the lowest diameter of corm (0 .99 cm) was recorded from the closest plant spacing (25 cm x 10 cm). This might be due to more availability of space and resources such as nutrients, water, light etc. in wider plant spacing which resulted in better growth and development of corm and cormel per plant. The present findings are in agreement with the results reported by [16] where closer spacing reduced the average weight of cormel. Combined effect of cut corm and plant spacing was found to be significant in respect of diameter of cormel but their interaction effect was non-significant (Table 4). The maximum diameter of cormel (1.19 cm) was obtained from the treatment combination of 1/2 cut corm (15 ± 2 g) and widest plant spacing (25 cm x 25 cm) and minimum (0.92) was recorded from the treatment combination of 1/4 cut corm size (15 ± 2 g) and the closest spacing (25 cm X 10 cm) (Table 4).

Weight of Cormels Plant^{-1}: The different cut corms had significant effect on the weight of cormels per plant (Table 3). The weight of cormels per plant varied from 8.80 to 9.30 g. The plant from 1/2 cut corm produced the highest total weight of cormels per plant and the lowest weight of cormels per plant was noticed from the 1/4 cut corm size. The increased weight of cormels per plant with the 1/2 cut corm was probably due to the higher amount of stored food materials present in the 1/2 cut corm during planting which contributed towards better vegetative growth and higher average weight of cormels per plant [9] also reported similar results. There was significant variation in the total weight of cormels per plant due to the effect of different plant spacing (Table 3). It varied from 8.61 to 9.93 g. The highest weight of cormels per plant was obtained from the widest plant spacing (25 cm x 25 cm). On the other hand, the lowest weight of cormels was recorded in case of the closest plant spacing (25 cm x 10 cm). Combined effect of cut corm and plant spacing on cormels weight per plant was statistically significant but their interaction effect was non- significant (Table 4). It was found that maximum cormels weight per plant (87.78 g) was produced with the whole corm size (15 ± 2 g) and the widest plant spacing (25 cm x 20 cm) while the minimum (68.73 g) was in case of 1/3 cut corm size (15 ± 2 g) and the closest spacing (25 cm x 10 cm) (Table 4).

Weight of Cormel Plot^{-1}: There was significant effect of different cut corm on the weight of cormels per plot (Table 3). Maximum cormel weight per plot (315.6 g) was obtained from planting 1/2 cut corm size while minimum cormel weight (210.4 g) was given by 1/4 cut corm size (Table 3). There was significant variation in the total weight of cormels due to the effect of different plant spacing (Table 3). It varied from 213.7 to 27905 g. The highest weight of cormels per plot was obtained from the closest plant spacing (25 cm x 10 cm). On the other hand, the lowest weight of cormels was recorded in case of the widest plant spacing (25 cm x 25 cm). Combined effect of cut corm and plant spacing was found significant in weight of corms per plot and but their interaction effect was non- significant (Table 4). The maximum cormel weight per plot (340.4 g) was recorded from the 1/2 cut corm size (15 ± 2 g) with closer spacing (25 cm x 15 cm) while the minimum (180.0 g) was recorded in case of 1/4 cut corm size (15 ± 2 g) with widest (25 cm x 25 cm) spacing of plant (Table 4).

Yield of Flowers (Lac or USD/ha): There was significant variation among cut corms in respect of number of flowers per hectare. The maximum number of flowers per hectare (2.4 lac/ 3000USD) was found with (15 ± 2 g) 1/2 cut corm size whereas the minimum (0.93 lac/ 1165 USD) was with (15 ± 2 g) 1/4 cut corm size (Table 3). The effect of different plant spacing on number of flowers per hectare was significant (Table 3). The maximum number of flowers per hectare was obtained from the closest spacing (25 cm X 10 cm) and the minimum was under the widest spacing (25 cm X 25 cm). Similar result was also reported by [13]. Combined effect of cut corm and plant spacing on the number of flowers per hectare was significant (Table 4). The 1/2 cut corm size (15 ± 2 g) and wider spacing (25 cm x 15 cm) produced maximum number (2.92 lac/3650 USD) of flower per hectare while it was minimum (0.67 lac/ 838 USD) with 1/4 cut corm size (15 ± 2 g) and the widest spacing of (25 cm x 25 cm) (Table 4). [14] observed maximum numbers of flowers per hectare with the treatment combination of the largest corm size and the widest plant spacing.

Yield of Corms (t/ha): There was significant effect of different cut corms on the corm yield of gladiolus (Table 3). The maximum corm yield (24.51 t/ha) was recorded from whole corm size and the minimum corm yield (12.79 t/ha) was with the 1/4 cut corm size (Fig. 3). Similar results were reported by [12]. The yield of corm per hectare was significantly influenced by plant spacing (Table 3). The highest yield of corms per hectare (23.08 t/ha) was recorded from the closest spacing (25 cm x 10 cm), while the lowest yield of corm per hectare (12.64 t/ha) was obtained from the widest plant spacing (25 cm x 25 cm) (Fig. 3). Combined effect of cut corm and plant spacing was found significant in corm yield per hectare but their interaction effect was found non- significant (Table 4). The highest corm yield (32.33 t/ha) was produced due to the combined effect of whole corm size (15 ± 2 g) and the closest (25 cm x 10 cm) plant spacing, while it was the lowest (7.43 t/ha) in case of 1/4 cut corm size (15 ± 2 g) and widest (25 cm x 25 cm) plant spacing (Table 4).

Table 4: Combined effect of cut corm and plant spacing on yield component character of gladiolus

Interaction (Corm cut level × plant spacing)	Corm diameter (cm)	Corm weight $plant^{-1}$ (g)	Corm weight $plot^{-1}$ (g)	Number of cormel $plant^{-1}$	Cormel diameter (cm)	Cormel weight $plant^{-1}$ (g)	Cormel weight $plot^{-1}$ (g)	Yield of flower (lac or USD/ha) 1 lac = 1250USD	Yield of corm (t/ha)	Yield of cormel (t/ha)
C_1S_1	5.02	69.39	7	25.42	0.95	9.36	313	2.67	32.33	1.04
C_1S_2	5.32	75.5	6.8	26.56	0.95	9.52	293.3	2.57	24.67	0.91
C_1S_3	5.36	78.61	4.92	27.97	1.01	9.83	240	2.05	22.33	0.82
C_1S_4	5.44	80.11	3.84	28.42	1.03	0.42	217.7	1.87	13.7	0.72
C_2S_1	5.36	73.61	5.68	27.83	1.12	8.89	335	2.77	25.43	1.13
C_2S_2	5.39	77.22	6.99	29.22	1.14	9.06	340.4	2.92	26.63	1.11
C_2S_3	5.1	80.41	5.32	30.25	1.17	9.19	310	2.21	24.67	1.03
C_2S_4	5.41	83.75	4.22	30.39	1.19	0.06	277	1.72	21.33	0.92
C_3S_1	3.92	47.22	4.83	23.01	0.97	7.79	243.3	1.51	17.33	0.84
C_3S_2	4.07	51.11	4.63	23.22	0.98	8.72	253.1	1.14	11.67	0.81
C_3S_3	4.57	61.25	3.67	23.5	0.98	9.27	195	0.84	8.33	0.65
C_3S_4	4.38	62	3	24	1.02	9.94	180.3	0.71	7.43	0.6
C_4S_1	3.55	44.44	3.62	20.22	0.92	8.39	226.7	1.33	17.23	0.75
C_4S_2	3.62	45	3.6	21.11	0.94	8.64	223.3	1.01	12.97	0.71
C_4S_3	4.02	49.3	2.95	21.17	0.95	8.86	211.6	0.73	12.87	0.7
C_4S_4	3.64	50.92	2.43	23.72	1.03	9.31	180	0.67	8.1	0.6
Level of sig.	*	**	**	*	NS	**	**	**	**	*
LSD (0.05)	0.43	3.96	0.74	3.01	0.063	0.46	22.1	0.4657	7.963	0.1179
LSD (0.01)	1.58	5.3	0.99	6.02	0.08	0.6	29.61	0.6271	10.72	0.1588
CV (%)	5.63	3.68	9.68	7.11	3.07	2.98	5.25	12.26	2.43	7.04

*, ** indicate significant at 5% and 1% level of probability, respectively

C1 = Whole corm of 15 g ± 2; C2 =1/2 cut corm, each cut 15 g ± 2;

C3 = 1/3 cut corm, each of 15 g ± 2 and C4 = 1/4 cut corm, each of 15 g ± 2;

S1 = Plant spacing of 25 cm × 10 cm; S2 = Plant spacing of 25 cm × 15 cm

S3 = Plant spacing of 25 cm × 20 cm and S4 = Plant spacing of 25 cm × 25 cm

Yield of Cormels (t/ha): There was significant variation due to the effect of different cut corms on cormel yield (Table 3). The highest yield of cormels per hectare (1.04 t/ha) was found with 1/2 cut corm size (15 ± 2 g) and the lowest (0.69 t/ha) was recorded from 1/4 cut corm size (15 ± 2 g) (Table. 3). The yield of cormels per hectare was significantly influenced by plant spacing (Table 3). The maximum yield of cormels (0.94 t/ha) was recorded from the cloest spacing (25 cm x 10 cm) while the minimum yield of cormels (0.71 t/ha) was obtained from the widest spacing (25 cm x 25 cm) (Table 3). Combined effect due to cut corm and plant spacing in respect of yield of cormels was found significant but their interaction effect was non-significant (Table 4). The highest yield of cormels per hectare (1.13 t/ha) was found with the treatment combination of 1/2 cut corm size (15 ± 2 g) and closet the closest (25 cm x 10 cm) plant spacing, while it was the minimum (0.60 t/ha) with 1/4 cut corm (15 ± 2 g) and the widest (25 cm x 25 cm) plant spacing (Table 4).

CONCLUSIONS

In this study, we found that the highest yield of flowers (2.92 lac/3650 USD) was recorded from the treatment combination of 1/2 cut corm and closer spacing (25 cm x 15 cm). The highest yields of corm (32.33 t/ha) was obtained from the treatment combination of whole corm and closest spacing (25 cm x 10 cm) and highest yields of cormel (1.13 t/ha) from the treatment combination of 1/2 cut corm and the closest (25 cm x 10 cm) spacing. The closest plant spacing (25 cm x 10 cm) was found superior here. Considering the above findings, the combination of 1/2 cut corm with 25 cm x 10 cm spacing was found to be the best for the production of good quality spike, corm and cormel of gladiolus and it will be used for further studies applied to gladiolus production programs.

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