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Influence of Nitrogen on Growth Performance, Cut Flower Characteristics and Corm/Cormel Production of Gladiolus

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Abstract

A study was carried out to access the influence of nitrogen level (100, 150, 200, 250, 300 kg/ha) on growth performance, cut flower characteristics and corm/cormel production of three varieties (American beauty, Interpret and Candyman) of gladiolus (*Gladiolus hybrida* L.) in the farmer's field at Gunjanagar VDC, Chanauli, Chitwan, during September, 2010 to April, 2011. The experiment consisted of 15 treatment combinations laid out in 2 factorial randomized complete block design (RCBD) with 4 replications. Nitrogen levels significantly influenced growth performance, cut flower characteristics and corm/cormel production of gladiolus. Increasing the level of nitrogen up to 200 kg/ha, increased the rate of sprouting (97.33%), number of sprout/corm (2.05), taller plant (106.7cm) with more number of leaves (9.85), longest spike(86.58cm) with more number of florets/spike (16.73) were produced. Moreover, largest spike (92.62 g weight) having thicker (1.14 cm girth) and longest rachis (54.5 cm) were produced by 300 kg/ha. Size of daughter corm (5.8 cm) was highest with 300 kg/ha while number of the cormels per plants (89.45) was highest at 200 kg/ha nitrogen. Among three varieties, Candyman performed better with respect to early days to sprouting (15.1), early days to 50% sprouting (23.1), higher total sprouting percentage (97.6%), more number of leaves/plant at harvest (10.76), highest plant height (136.8 cm) at harvest, highest length of spike (81.6 cm), more weight of spike (81.78 g), thicker spike (1 cm) and longest rachis (51.1 cm).

Key words: corm, cormel, cut flower, gladiolus, nitrogen, spike

Introduction

Flowers have long and romantic historical relationship with mankind from the dawn of civilization. It is said that man is born with flowers, lives with flowers and finally dies with flowers. Floriculture is fast expanding in trade. World trade in ornamental horticulture is estimated to be in excess of US$ 55 billion (Singh 2005) and it is predicted to be 30 % greater by 2014 AD (FAN 2007). Cut flower business has shown steady and continuous development in Nepal. The total turnover of this sector increased from Rs. 10 million in 1992/93 to Rs. 560 million in 2008/09 (FAN 2010). Along with the urbanization and modernization, the demand of the cut flower has increased tremendously. The export of floricultural products increased from Rs. 4.0 million in 2001/02 to Rs. 29.2 million in 2008/09 (FAN 2010).

Gladiolus (*Gladiolus hybrida* L.) is the largest grown cut flower in Nepal which occupies the top position with 70% of all sales. It is the first commercially grown cut flower crop in Nepal in 1988. It ranks number one in terms of production and consumption in Nepal (Pun 2004) occupying 350 Rh of land under its cultivation (FAN 2010). The demand of gladiolus spikes is 4000-5000 daily in Kathmandu (FAN 2010) and around 800000 spikes were produced annually (Gauchan *et al*. 2009).

Gladiolus respond well to well balanced nutrition for maximum flower production and better growth. Inadequate plant nutrition causes serious disorders

and may eventually lead to decline of plant vigor and yield. Fertilizer application also affects flower color of gladiolus but not in a systematic manner. The requirement of fertilizers for gladiolus, like other crops has vital role in growth, quality of flowers, corm and cormel production. Nitrogen is considered to be most crucial among all the fertilizers because it is a constituent of protein and nucleic acid, which is helpful in plant growth (Haque & Jakhro 2001). However, very little research has been done on appropriate level of nitrogen and its relation on different aspect of gladiolus production. In Nepal, very few researches have been conducted to observe different traits of gladiolus. Lack of good quality corms/cormels is one of the bottlenecks in gladiolus production in Nepal. The corms and cormels produced in Nepal don't fulfill the local demand of planting material. It is high time, therefore, to streamline technology and standardize conventional propagation methods in order to produce quality flower spikes and maximize corm and cormel production.

Nepal imports large amount of corms/cormels from India, Japan, Thailand and Netherlands and is one of the most expensive inputs for commercial growers. If Nepalese farmers produce corm/cormel inside the country, this will result import substitution and export promotion potentialities. Dormancy of corm and cormels is one of the major hindrances in commercial cultivation of gladiolus. The physiological basis of corm and cormel dormancy has been ascribed to the accumulation of growth inhibiting substances, specially ABA (Kumar *et al*. 2007). Cold storage of corms at 4-5 ^{0}C for 3-4 months is widely followed practice for breaking the dormancy (Kumar *et al*. 2007). During cold storage, more than 30-40 % corms will be rotten and one of the reasons might be the higher level of nitrogen. Besides, the nitrogen level may not always be proportionate to the quality of the flower vase life and corm/cormel production as well as storability in Nepal. So far, no researches have been carried out on influence of nitrogen level and variety with respect to corm/cormel storability. In this context, present study was carried out to find the effect of nitrogen level and variety on vegetative growth, flower quality and corm/cormel production of gladiolus in Chitwan condition.

Methodology

To access the influence of nitrogen level on growth performance, cut flower characteristics and corm/cormel production of three varieties of gladiolus in the farmer's field at Gunjanagar VDC, Chanauli, Chitwan, during September 2010 to April 2011. The experiment consisted of 15 treatment combinations laid out in 2 factorial randomized complete block design (RCBD) with 4 replications. In this experiment five levels of nitrogen were applied (100, 150, 200, 250, 300 kg/ha) in three varieties of gladiolus viz. American Beauty, Interpret and Candyman were planted to find out the effect on growth performance, cut flower characteristics, and corm/cormels production under Chitwan condition. Well decomposed poultry manure was applied in all plots @ 7.500 t/ha two weeks before planting. Phosphorus (P), potash (K), multiplex, cytozyme, borax were applied at the rate of 100:75:30:30:22.5 kg/ha were applied in all plots, as basal dose. Nitrogen was splited in three doses. Half dose of nitrogen was applied as basal dose and remaining amount was further split into two parts. The first was top dressed when plants attained four leaf stage and second at six leaf stage (Singh *et al*. 2002). Nitrogen was applied through urea (46% N) and potash through murate of potash (60% K_2O) and phosphorus through diammonium phosphate (46% P_2O_5 & 16% N).

Nitrogen and varieties were two factors having five and three levels of each respectively. There were all together 15 treatments and replicated four times. The treatments were randomly allocated by using random number table (Gomez & Gomez 1984). Total experimental area was 213.9m^2 (23m ×9.3m). Space between replications and plots was 0.5m respectively. The individual plot size was 1.7m × 1m. The row to row distance was 30 cm and plants were spaced at 20 cm. There were 4 rows in each plot and 6 plants were accommodated in each row. There were 24 plants in each plot from which 5 inner plants were selected for observation. Corms were planted on 4th November, 2010. Same sizes of corms of three varieties were randomized in experimental plot. The corms were planted in furrows at 7 cm depth in soil spaced at 30 cm between rows and 20 cm between plants. Standard cultural operations were followed for successful production of cut flowers. The field was irrigated at 45 and 75 DAP

which was followed by side dressing of with ¼th nitrogen and earthing up. Periodic weeding was done in the experimental plot to reduce the weed population. Spikes were harvested at the tight bud stage (first basal floret showing color) with two bract leaves in spike leaving as much leaves as possible on plant for the proper maturation of corm and cormels. Five representative plants from the two inner rows of each plot were labeled and tagged in each replication and were used for recording for the days to sprouting, days to 50 % sprouting & sprouting percentage, number of sprout per corm, number of leaves per plant, plant height, spike length, rachis length, number of floret/spike, weight of spike, girth of spike, number of corms per plant, weight of corms per plant, size of corms, number of cormels per plant, weight of the cormels per plant.

The collected data were entered in the spread sheet in Microsoft Excel programs were analyzed by using MSTAT-C software package. The means were compared by using DMRT.

Results and Discussion

Effect of nitrogen level and varieties on days to sprouting, days to 50 % sprouting, sprouting percentage and number of sprout per corm

Days to sprouting, days to 50 % sprouting, sprouting percentage and number of sprout per corm varied significantly among the different level of nitrogen (Table 1) which were supplied with 200 to 250 kg nitrogen/ha sprouted earlier (15.7 days), took minimum number of days to 50 percent sprouting, took the maximum days (24.8 days) to 50 % sprouting and highest number of sprouting (97.33%). Similarly, these parameters varied significantly among different varieties (Table 1). Candyman sprouted earlier (15.1 days) followed by Interpret (16.18 days). Interpret was the earliest (23.1 days) to 50% sprouting which was at par with days taken by Candyman (23.16 days). Maximum sprouting % (97.6%) was recorded in Candyman followed by Interpret (97.4%). American Beauty produced the maximum number of sprout per corm (2.1) followed by Candyman (2.08) while least number of sprout per corm (1.75) was recorded in Interpret.

Table 1. Effect of nitrogen level and varieties on days to sprouting and number of sprouts per corm in gladiolus under Chitwan condition, 2010/2011

Treatments	Days to sprouting	Days to 50% sprouting	Total sprouting (%)	Number of sprout/corm
Nitrogen level (kg/ha)				
100	16.42[b]	24.2[b]	97.33[a]	1.78[b]
150	16.42[b]	24.2[b]	97.33[a]	1.83[b]
200	15.75[c]	23.73[c]	97.33[a]	2.05[a]
250	15.70[c]	23.32[d]	97.33[a]	2.11[a]
300	17.4[a]	24.82[a]	94.83[b]	2.1[a]
SEM±	0.07	0.06	0.49	0.07
$LSD_{0.05}$	0.22	0.18	1.4	0.2
Varieties				
American Beauty	17.73[a]	25.90[a]	95.5[b]	2.1[a]
Interpret	16.18[b]	23.1[b]	97.4[a]	1.75[b]
Candyman	15.1[c]	23.16[b]	97.6[a]	2.08[a]
Mean	16.33	24.05	96.83	1.64
SEM±	0.06	0.05	0.38	0.05
$LSD_{0.05}$	0.17	0.14	1.09	0.13
CV%	1.67	0.94	1.78	9.56

Means within the column for nitrogen level and varieties followed by the same letter are not significantly different at 5% level of significance by DMRT. SEM = Standard Error of Mean, LSD = Least Significant Difference and CV = Coefficient of Variation and ns = non significant.

Table 2. Effect of nitrogen level and varieties on number of leaves per plant and plant height at harvesting stage in gladiolus under Chitwan condition, 2010/2011

	Number of leaves/ plant at harvest	Plant height at harvest (cm)
Nitrogen level (kg/ha)		
100	9.61[b]	105.8[b]
150	9.6[b]	110[a]
200	9.85[a]	106.7[ab]
250	9.81[ab]	107.1[ab]
300	9.71 [ab]	105.7 [b]
SEM±	0.07	1.35
$LSD_{0.05}$	0.2	3.86
Varieties		
American Beauty	9.72[b]	107.1[b]
Interpret	8.68[c]	77.3[c]
Candy Man	10.76[a]	136.8[a]
Mean	9.72	107.05
SEM±	0.05	1.04
$LSD_{0.05}$	0.15	2.99
CV%	2.57	4.38

Means within the column followed by the same letter for nitrogen level and varieties are not significantly different at 5% level of significance by DMRT. SEM = Standard Error of Mean, LSD = Least Significant Difference and CV = Coefficient of Variation and ns = non significant.

Effect of nitrogen level and varieties on number of leaves and plant height at harvest

Number of leaves and plant heights differed significantly (0.05% level) at harvest stage. The highest numbers of leaves per plant (9.8) were recorded at 200 and 250 kg/ha N dose followed by 300 kg/ha (9.7) and least number of leaves per plant (9.6) was produced by 100 and 150 kg/ha (Table- 2). Taller plant (110 cm) were produced by 150 kg/ha nitrogen which was at par with 200 and 250 kg/ha. Candyman produced the maximum number of leaves per plant (10.76) and the highest plant height (136.8 cm) was recorded followed by American Beauty (Table-2).

Effect of nitrogen level and varieties on spike length, rachis length, number of floret/spike, weight of spike and girth of spike

The analysis of variance showed that, the effect of nitrogen level on spike length was highly significant (Table 3). Higher the level of nitrogen (300 kg/ha), longest spike was produced (86.5 cm). The longer spikes from higher nitrogen level might be due to protoplasm formation, division and elongation of meristem cells, enhancing the biosynthesis of proteins and carbohydrates which lead to enhancing the growth (Verma *et al*. 2000). Similar result was reported by Sehrawat *et al*. (2003). The tested varieties differed significantly with respect to spike length (65.82 cm to 86.58 cm, Table 3). Among the varieties, Candyman recorded the longest spikes (81.6 cm) followed by Interpret (79.16 cm) and the lowest spike length was recorded in American Beauty (77.4 cm). Varietal variation in spike length was also reported by Khanna and Gill (1983); Lal *et al.* (1984); Sindhu and Verma (1995); Shakya (2006) and Poon (2009), Joshi (2009).

Statistical analysis showed (Table 3) that five different nitrogen levels showed highly significant variations in their spike weight. Plants grown in 300 kg/haN yielded the maximum spike weight (92.62 g) which was statistically at par with spike weight 87.77 g from 250 and 84.79 g from 200 kg/haN, while minimum spike weight (52.78 g) was yielded by plants grown from 100kg/haN. A similar increase in weight of spike with increasing level of nitrogen was reported by Charles (1962), Collins and Duke (1981), Bijimol and Singh (2000). Highly significant variations were found among the tested varieties on spike weight (Table 3). Mean Table showed that the Candyman yielded the maximum spike weight (81.78 g) followed by American Beauty (77.66 g). Similar result was also reported by Khanna and Gill (1983); Lal *et al.* (1984) and Poon (2009).

Highly significant variation was found among different levels of nitrogen on spike girth (Table 3) which ranged from 0.92 to 1.14 cm. 300kg/haN produced the maximum spike girth (1.14 cm), which was statistically at par with spike girth from 250kg/haN. Similar increase in spike girth from increasing levels of nitrogen was reported by Charles (1962), Collins and Duke (1981), Bijimol and Singh (2000). The result of statistical analysis revealed that the tested varieties did not differ significantly on spike girth (Table 3). Significant variation (0.05 % level) was found among the different levels of nitrogen on rachis length (Table 3). Mean Table showed that the 300 kg/haN produced the longest rachis (54.5 cm) whereas 100kg/haN produced the shortest ones (40.5cm). The differences in rachis length depend on various factors like length of spike, number of florets/spike, inter nodal distance between florets, and also the amount of fertilizers applied

during growth stages and its subsequent effect on further performance. This finding is in conformity with that of Mukesh *et al.* (2000), Bijimol and Singh (2000). The effect of varieties on rachis length was found significant (Table 3). Candyman produced the longest rachis (51.1 cm) which was statistically at par with rachis length of Interpret (48.7 cm).

Significant variation on number of florets/spike was recorded among the different level of nitrogen (Table 3). It varied from 13.4 to 16.93. One hundred and fifty kilogram of N yielded the spikes with a maximum number of florets (16.93) which was statistically at par with 200 and 100 kg N on florets per spike (i.e., 16.73 & 16.26) This finding is in conformity with that of Bijimol and Singh (2000). They conducted an experiment to assess the effect of spacing and nitrogen levels on flowering, flower quality and vase life of gladiolus cv. Red Beauty. Highly significant variations were recorded among the tested varieties on number of florets per spike (Table 3). American Beauty yielded the spikes with maximum number of florets (16.28) which was statistically at par with number of florets per spike of Interpret (15.48). Varietal variation in number of florets/spike was also reported by Sindhu and Verma (1995); Regmi (2000) and Poon (2009).

Table 3. Effect of nitrogen level and varieties on cut flower characteristics of gladiolus grown under Chitwan condition, 2010/2011

Treatments	Length of spike (cm)	Weight of spike (g)	Girth of spike (cm)	Length of rachis (cm)	Number of florets spike^{-1}
Nitrogen level (kg/ha)					
100	65.42^{c}	52.78^{c}	0.92^{b}	40.5^{c}	16.26^{a}
150	72.08^{b}	68.45^{b}	0.92^{b}	45.91^{b}	16.93^{a}
200	86.58^{a}	84.79^{a}	0.91^{b}	53.16^{a}	16.73^{a}
250	86.5^{a}	87.77^{a}	1.08^{a}	52.66^{a}	15.13^{b}
300	86.25^{a}	92.62^{a}	1.14^{a}	54.5^{a}	13.4^{c}
SEM±	1.2	2.62	0.23	1.1	0.38
$LSD_{0.05}$	3.4	7.47	0.67	3.14	1.07
Varieties					
American Beauty	77.4^{b}	75.66^{b}	0.97	48.25^{b}	16.28^{a}
Interpret	79.16^{ab}	74.41^{b}	1	48.7^{ab}	15.48^{ab}
Candyman	81.6^{a}	81.78^{a}	1	51.1^{a}	15.32^{b}
Mean	79.36	77.28	9.9	49.35	15.69
SEM±	0.94	2.02	NS	0.85	0.29
$LSD_{0.05}$	2.7	5.79	NS	2.43	0.83
CV%	5.33	11.74	8.22	7.75	9.42

Means within the column followed by the same letter for nitrogen level and varieties are not significantly different at 5% level of significance by DMRT. SEM = Standard Error of Mean, LSD = Least Significant Difference and CV = Coefficient of Variation.

Effect of nitrogen levels and varieties on corm and cormels

Number of daughter corms produced among different levels of nitrogen was found non significant (Table 4). However the trend indicated that American Beauty yielded the maximum number of daughter corms (2.24). Highly significant variation was recorded on size of daughter corms produced among different levels of nitrogen (Table 4). The biggest size of daughter corms (5.8 cm) was produced by 300kg N followed by 250 kg (5.7 cm). Highly significant variation was observed on the size of daughter corms among the tested varieties (Table 4).

Table 4. Effect of nitrogen level and varieties on corm and cormel characteristics of gladiolus under Chitwan condition, 2010/2011

Treatments	No. of daughter corms	Size of daughter corms (cm)	Weight of daughter corms (g)	No. of cormels/ plant	Weight of cormels (g)
Nitrogen level (kg/ha)					
100	1.95	5.57^{b}	78.33	67.48^{bc}	0.01
150	1.88	5.7^{a}	76.33	57.62^{c}	0.009
200	2.13	5.54^{b}	76.71	89.45^{a}	0.01
250	2.05	5.7^{ab}	82.38	74.47^{b}	0.009
300	1.71	5.8^{a}	69.68	75.95^{ab}	0.01
SEM±	NS	0.07	NS	4.74	NS
$LSD_{0.05}$	NS	0.2	NS	13.55	NS
Varieties					
American Beauty	2.24^{a}	5.49^{b}	74.06^{b}	94.57^{a}	0.01
Interpret	1.51^{b}	5.08^{c}	49.69^{c}	62.08^{b}	0.008
Candyman	2.09^{a}	6.5^{a}	106.32^{a}	62.33^{b}	0.01
Mean	1.94	5.69	76.69	72.99	0.01
SEM±	0.24	4.25	4.61	3.67	NS
$LSD_{0.05}$	0.08	0.07	13.17	10.49	NS
CV%	19.87	0.2	26.91	22.53	32.29

Means within the column followed by the same letter for nitrogen level and varieties are not significantly different at 5% level of significance by DMRT. SEM = Standard Error of Mean, LSD = Least Significant Difference and CV = Coefficient of Variation and ns=non significant.

Biggest sized daughter corms (6.5 cm) were produced by Candyman followed by American Beauty (5.49 cm). Similar variation among varieties with respect to weight of daughter corms was also reported by Sindhu and Verma (1995); Shakya (2006) and Poon (2009). Weight of daughter corms produced among different levels of nitrogen was found statistically non significant (Table 4). Weight of the daughter corms of the tested varieties was found highly significant (Table 4). Highest weight of daughter corms (106.32 g) was found in Candyman followed by American Beauty (74.06 g). Similar variation among varieties with respect to weight of daughter corms was also reported by Shakya (2006); Sindhu and Verma (1995); Joshi (2009) and Poon (2009). Variation in number of cormels per plant was found highly significant due to differences in nitrogen level (Table 4). 250 kg N produced significantly more number of cormels per plant. Sehrawat *et al.* (2003) reported that number of cormels per plant was significantly influenced by the increment of nitrogen level. The effect of varieties on number of cormels per plant was found to be highly significant (Table 4). It varied from 62.08 to 94.57. American Beauty yielded the maximum number of cormels per plant (94.57) while the lowest numbers of cormels per plant (62.08) were found in Interpret (Table 4).

Generation of appropriate production technology is an important subject for the promotion of export business in Nepal of gladiolus cut flower. For the promotion of this cut flower as an export product, research and study must be directed towards the development of appropriate production technology in different geographical zone.

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