Pak. J. Bot., 45(3): 967-976, 2013.

YIELD AND QUALITY OF CUT FLOWERS AND CORM PRODUCTION OF GLADIOLUS VARY BY CULTIVAR AT THREE LEVELS OF NITROGEN FERTILITY

MUHAMMAD ZUBAIR, GOHAR AYUB,* NOOR UL AMIN, ABDUR RAB, MASOOD AHMAD AND NEELAM ARA

Department of Horticulture, The University of Agriculture, Peshawar, Pakistan.
**Corresponding author e-mail: gohar.ayub@aup.edu.pk*

Abstract

Nitrogen plays an important role in the production and quality of crop through enhancing vegetative growth. In spite of this fact, if it is applied in excess of the requirement of the crop then it pollutes both ground water and environment. Hence an optimum level of nitrogen needs to be investigated for Gladiolus crop. Eight cultivars viz., Deciso, Hong Kong, Jessica, Jester Ruffled, Madonna, Peters Pears, Rose Supreme and White Friendship were evaluated at three nitrogen levels (0, 100 and 200 kg ha^{-1}). Cultivar Rose Supreme produced the biggest florets (1.4 cm) both at color showing and full open stage (12.1 cm), lengthiest spikes (122.5 cm) at full spike opening, maximum number of 17.2 florets spike^{-1}, maximum first florets persistency (8.0 days), maximum number of 138.8 cormels mother corm^{-1} and the largest daughter corm (7.8 cm). Jessica yielded maximum number of spikes (1.4), and daughter corms (1.6) mother^{-1} corm. Jester Ruffled produced maximum spike lengths (97.6 cm) at first floret opening. Nitrogen did not show a significant effect on most of the yield and quality characteristics but a significant effect on the first florets size was observed where a linear increase in first florets size was associated with an increase in nitrogen levels.

Introduction

Nitrogen being an important plant nutrient is becoming a threat to the modern civilization. It pollutes the water and environment through leaching and denitrification processes when it is applied in excess of the requirement of crops. We are fortunate to realize this problem at an earlier stage and can be controlled easily at this stage through judicious use of nitrogen fertilizers. Eight cultivars of Gladiolus were evaluated at three nitrogen fertility levels to investigate an optimum level of nitrogen. Gladiolus *Gladiolus grandiflorus* belongs to the family *Iridaceae*. Gladioli are principally native to South Africa, with some species found in the wild in southern Europe and the Near East. This plant is used to a limited extent for landscape effect and medicinal value; their chief value is for cut flowers. Their wide range of colors, sizes and flower types makes them particularly useful for flower arrangements. Soils are more commonly deficient in nitrogen than any other element. Because nitrogen is present in so many essential compounds, it is not surprising that growth without added nitrogen is slow (Salisbury & Ross 1992). Nitrogen deficiency can be manifest as a reduction in number of spikes and number of florets spike^{-1} in gladiolus as well as the typical pale green foliage (Wilfret, 1980). Optimum size of flower is achieved with the use of NPK (Mutia *et al*., 1998) and size of fruit (Iqbal *et al*., 2011), however higher doses delay maturity and increase lodging (inamullah *et al*., 2012). Besides, variation in flower color or spike color could be minimized by manipulating the fertilizer regime (Devecchi and Barni 1997).

Nitrogen is one of the most important nutrients that encourage the vegetative growth and consequently the good quality flowers productions. If the gladiolus is grown for the first year only then it does not need to be fertilized as it is a bulbous plant and has enough food materials. Nevertheless, if it is used commercially then it needs to be fertilized with all the essential nutrients.

Gladiolus cultivars respond differently to nitrogen (Sidhu & Arora, 1989). Nitrogen enhances the yield and quality of cut flowers (Sidhu & Arora, 1989, Chattopadhyay *et al*., 1992, Amen & Kovanci, 1990, Pandey *et al*., 2000, Singh, 2000, Jhon *et al*., 1997, Mukherjee *et al*., 1994) and corm (Barma *et al*., 1998, Singh *et al*., 1990, Jhon *et al*., 1997, Singh, 1996). Application of nitrogen with phosphorus can also enhance florets, corms, corm lets and spike length (Lehri *et al*., 2011).

Keeping in view the aforementioned facts, the present experiment was planned to find the optimum level of nitrogen under the prevailing environmental conditions of Peshawar, Pakistan.

Materials and Methods

An experiment was conducted at the Agriculture Research Farm, Department of Horticulture, Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan, during the year 2003-05.

Cultivars Deciso, Hong Kong, Jessica, Jester Ruffled, Madonna, Peters Pears, Rose Supreme, and White Friendship were used in the experiment. These cultivars were arranged alphabetically. The corms of these cultivars were fertilized with Nitrogen (N) @ 0 (control), 100 and 200 kg ha^{-1}. Urea [CO $(NH_2)_2$] was used as a source for nitrogen. The nitrogen was applied in split doses. First dose was applied at the time of corm plantation and the second dose was applied at six-leaf stage.

Farm yard manure was mixed in the field @ four loaded tractor trolleys ha^{-1}. A basic dose of phosphorus and potassium were added to the field @ 100 kg each ha^{-1} before plantation of the corms. All the cultural practices were performed uniformly. The soil was analyzed for physico-chemical properties and the following information were noted: Sand (17.12%), silt (54%), clay (28.88%), pH (8.32), EC (0.33 dsm^{-1}), N (100% deficient), P (27% deficient and 73% marginal), K (50% marginal and 50% adequate).

The corms were imported from Netherlands through a reliable commercial nursery 'SUNNY SEEDS' in Lahore, Pakistan. The corms were planted in a wellprepared field at a depth of 10 cm (Hartmann *et al*., 1981). The corms were planted in a row at a distance of 20 cm while the rows were made at a distance of 60 cm.

The experiment was laid out as RCBD (Randomized Complete Block Design) with split plot arrangement. The nitrogen levels were put in main plots whereas the cultivars were placed in subplots. The data were analyzed with the general linear model procedures in SAS (SAS Institute, ver. 6.12, Cary, N. C.), and the least significant difference (LSD) test was used for the means separation.

The following growth parameters were studied: **1**. Floret Size (cm) at the Time of Color Showing (FSCS), **2**. Full Opened Floret size (cm) (FSFO), **3**. Spike lengths (cm) at the Time of First Floret Opening (SLFFO), **4**. Spike Lengths (cm) at Full Spike Opening (SLFSO), **5**. Average number of florets spike^{-1} (Florets Spike^{-1}), **6**. Average Number of Spikes Corm^{-1} (Spikes Corm^{-1}), **7**. First Floret Persistence (in days) (FFP), **8**. Last Floret Persistence (in days) (LFP), **9**. Average Number of Daughter Corms Mother^{-1} Corm (DC M^{-1}C), **10**. Average Number of Cormels Mother^{-1} Corm (Cormels M^{-1}C), **11**. Average Diameter (cm) of Daughter Corm (DDC), **12**. Average Diameter (cm) of Cormels (DC).

Results and Discussion

The recorded data pertaining to various growth parameters of gladiolus was analyzed statistically and is presented in the form of means and analysis of variance (ANOVA) tables. Concise analyses of variance, means tables and graphs are presented for the interpretation of results. The means of different factors and their interactions if significant are interpreted in the following pattern, years, nitrogen levels, years X nitrogen levels, cultivars, years X cultivars, nitrogen levels X cultivar and years X nitrogen levels X cultivars for each growth parameter studied.

First floret size at color showing (in cm): Years, nitrogen levels and interactions (years X nitrogen levels and year X cultivars) significantly affected sizes of the first florets of gladiolus cultivars at the time of color showing (Table 1). Sizes of first florets were greater in year 1 (1.3 cm) as compared to year 2 (1.2cm) (Table 2). An increase in nitrogen levels caused a linear increase in the size of first florets at the time of color showing (Fig. 1).

Table 1. Results of ANOVA on florets size both at color showing (FSCS) and full opened stage (FSFO), spike lengths both at first florets (SLFFO) and full spike opening (SLFSO), average number of florets spike^{-1} (florets spike^{-1}) and spikes corm^{-1}(spikes corm^{-1}) of gladiolus cultivars fertilized with nitrogen (0, 100 and 200 kg/ha) during 2003-04 and 2004-05.

Source	DF	FSCS (cm)	FSFO (cm)	SLFFO (cm)	SLFSO (cm)	Florets spike^{-1}	Spikes corm^{-1}
Model	59						
Error	84						
Corrected total	143						
Year (Y)	1	**	NS	**	**	**	NS
Rep(year)	4						
Nitrogen (N)	2	**	NS	NS	NS	NS	NS
Y X N	2	**	NS	**	NS	NS	NS
Rep (Y X N)	8						
Cultivar (C)	7	**	**	**	**	**	**
Y X C	7	*	**	**	**	**	**
N X C	14	NS	NS	NS	NS	NS	NS
Y X N X C	14	NS	NS	NS	NS	NS	NS

NS = *, ** Non-significant or Significant at p<0.05 or 0.01, respectively

Table 2. Effect of years (2003-04 and 2004-05) on FSCS, FSFO, SLFFO, SLFSO, florets spike^{-1}, spikes corm^{-1} of gladiolus cultivars.

Source	FSCS (cm)	FSFO (cm)	SLFFO (cm)	SLFSO (cm)	Florets Spike^{-1}	Spikes Corm^{-1}
Years						
Year 1(2003-04)	1.3	10.6	68.5	90.7	13.7	1.0
Year 2(2004-05)	1.2	10.8	88.9	107.9	16.4	1.0
Cultivars						
Deciso	1.3	11.0	85.9	108.6	15.5	1.1
Hong Kong	1.1	10.7	77.3	94.5	13.8	0.4
Jessica	1.2	10.6	65.9	85.1	16.2	1.4
Jester ruffled	1.3	10.3	97.6	117.3	16.0	1.0
Madonna	1.2	10.7	74.6	95.5	14.7	0.6
Peters pears	1.2	10.5	78.7	100.2	15.2	1.0
Rose supreme	1.4	12.1	91.9	122.5	17.2	1.2
White friendship	1.2	9.9	57.4	70.4	11.8	0.9

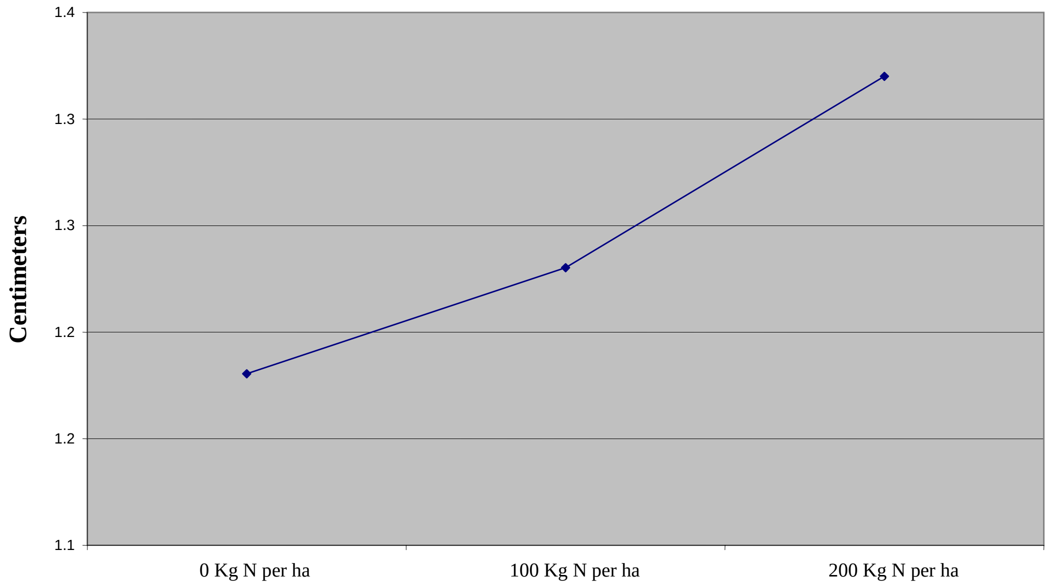

Fig. 1. First florets size at color sowing as affected by nitrogen levels.

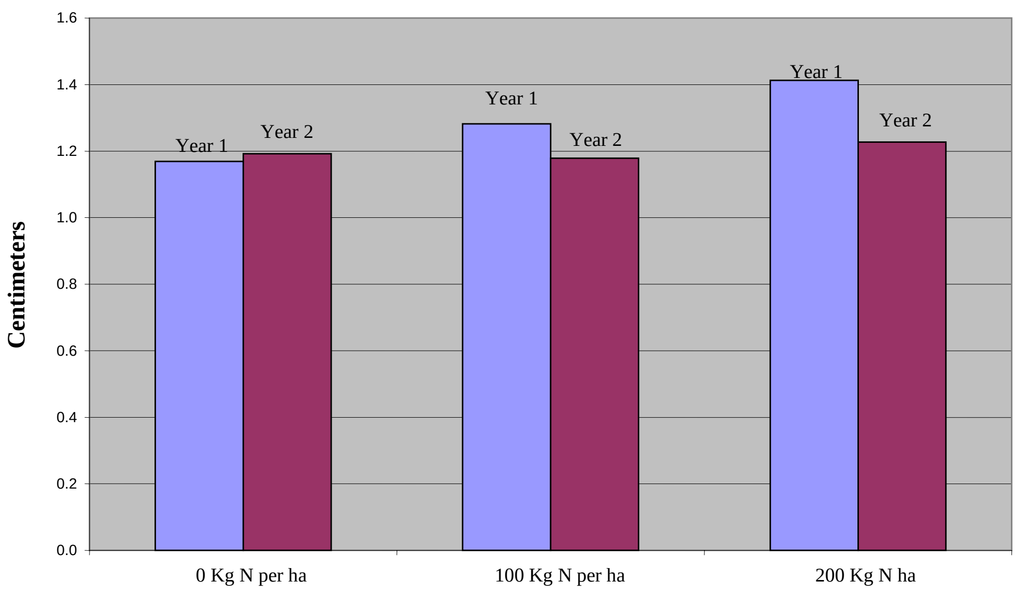

Fig. 2. Interaction (year X nitrogen) affected first florets size at color showing.

Plants responded differently in different years and produced first florets with significantly different sizes. The environment in year 1 may be favorable and hence resulted in bigger size florets at the time of color showing. An increase in nitrogen levels caused a linear increase in the size of first florets at the time of color showing. This might be due to the fact that nitrogen is a constituent of most essential compounds in a plant (Salisbury & Ross, 1992) and thus improves the quality of plants body. Environment also affects the availability and uptake of nitrogen. Hence nitrogen interacted with different years and produced florets with significantly different sizes in different years. There were more precipitation events in year 2 and this could be another reason that nitrogen in year 2 did not show significant effects as compared to year 1.

Cultivars on the other hand have different capability of producing florets with different sizes. Therefore, different sizes of florets were noted in different cultivars. Growth performance regarding floret sizes of different cultivars is different in different years. Therefore, interaction between years and cultivars was significant against floret sizes. It was further noted that cultivar Rose Supreme was superior in producing florets with maximum sizes.

Effect of nitrogen was different in different years and it was observed that an increase in nitrogen levels increased the size of the first florets in year 1 while in year 2 levels of nitrogen did not show any significant difference in the size of first florets at color showing (Fig. 2).

Size of the first florets at color showing were observed significantly different among various cultivars under test, cultivars Rose Supreme and Hong Kong produced maximum size (1.4 cm) and minimum size (1.1 cm) florets respectively at the time of color showing (Table 2).

According to the interaction between years and cultivars, Rose Supreme produced bigger size florets in year 1 with an average value of 1.5 whereas minimum size (1.1 cm) florets were observed in cultivars Hong Kong and White Friendship in year 1 and year 2 respectively (Table 3).

Full open florets size (cm): A significant interaction between years and cultivars against size of the full open florets of gladiolus cultivars was observed (Table 1). Maximum sizes of 12.1 cm of full opened florets were noted in cultivar Rose Supreme whereas the smallest (9.9 cm) full opened florets were observed in cultivar White Friendship (Table 2).

The response of cultivars in different years was significantly different. Cultivar Rose Supreme produced maximum size of full open florets with average values of 11.6 and 12.5 cm in year 1 and year 2 respectively. However, cultivars Jester Ruffled and White Friendship produced the smallest sizes of full opened florets in year 1 and year 2 respectively (Table 3).

A characteristic, size of full opened florets, is least affected by factors other than genetic make-up and therefore other factors did not affect size of full opened florets. As far as interaction between years and cultivars is concerned, cultivars contributed to this interaction and hence significantly affected size of first florets when fully opened.

Table 3. Effect of interactions on FSCS, FSFO, SLFFO, SLFSO, florets spike^{-1}, spikes corm^{-1} of gladiolus cultivars fertilized with nitrogen (0, 100 and 200 kg ha^{-1}) during 2003-04 and 2004-05.

Source			FSCS	FSFO	SLFFO	SLFSO	Florets	Spikes
Year	**x**	**Cultivars**	**(cm)**	**(cm)**	**(cm)**	**(cm)**	**spike^{-1}**	**corm^{-1}**
2003-04	x	Deciso	1.3	10.9	77.0	99.9	14.1	1.1
		Hong Kong	1.1	10.9	68.0	82.6	11.9	0.4
		Jessica	1.3	10.6	50.8	73.1	14.2	2.0
		Jester ruffled	1.3	9.6	90.0	104.9	12.9	0.4
		Madonna	1.3	11.2	66.8	94.7	14.4	0.8
		Peters pears	1.2	10.3	63.3	89.6	13.9	1.0
		Rose supreme	1.5	11.6	77.3	110.2	15.5	0.9
		White friendship	1.2	10.0	54.3	70.4	12.8	1.1
2004-05	x	Deciso	1.2	11.1	94.7	117.2	17.0	1.1
		Hong Kong	1.2	10.4	86.5	106.4	15.6	0.4
		Jessica	1.2	10.5	81.0	97.2	18.2	0.9
		Jester ruffled	1.3	11.1	105.2	129.7	19.2	1.6
		Madonna	1.2	10.2	82.4	96.3	14.9	0.3
		Peters pears	1.1	10.6	94.0	110.7	16.5	1.0
		Rose supreme	1.3	12.5	106.5	134.8	18.9	1.5
		White friendship	1.1	9.8	60.5	70.5	10.8	0.7

Spike lengths (cm) at first floret opening: Years and interactions (years X nitrogen, and years X cultivars) had a significant effect on spike lengths of gladiolus cultivars at the time of first floret opening (Table 1). According to the overall means for years, lengthy spikes of 88.9 cm were observed in year 2 as compared to year 1 where the spikes were of 68.5 cm long (Table 2). Nitrogen levels in different years showed different results and it was observed that the spike lengths increased with the medium levels (100 kg N ha^{-1}) and then decreased with the highest levels (200 kg N ha^{-1}) in year 1. This trend of increasing growth with increasing level of nitrogrn and then decreasing with further increase in nitrogen was also found by Sahfi *et al*., 2011; Hammad *et al*., 2011 and Ibrikcie *et al*., 2012. However, in year 2 the result was different from year 1 and it was recorded that the spike lengths were decreased with medium levels of nitrogen and increased with the highest levels (Fig. 3).

Lengthy spikes (97.6 cm) at the time of first florets opening were observed in cultivar Jester Ruffled followed by Rose Supreme that produced spikes with 91.9 cm lengths. However, shorter spikes (57.4 cm) were noted in cultivar White Friendship (Table 2). Cultivars under observation responded differently in different years and it was observed that cultivars Jester Ruffled produced lengthy spikes of 90.0 and 105.2 cm in year 1 and year 2 respectively. Nevertheless, Rose Supreme produced 106.5 cm lengthy spikes in year 2. However, shorter spikes (50.8 and 54.3 cm respectively) were noted in cultivar Jessica and White Friendship when grown in year 1 (Table 3).

Spike lengths might be environment dependent characteristic and thus different years had a significant effect on spike lengths at the time of first floret color showing. Interaction between years and nitrogen affected spike lengths and it might be due to greater contribution of different environments that existed in both years. As far as cultivars are concerned, it was observed that the spike lengths were significantly different among various cultivars. However, cultivars interacted with years and significantly affected spike lengths. This might be due to the fact that both environment and cultivars contributed to this interaction.

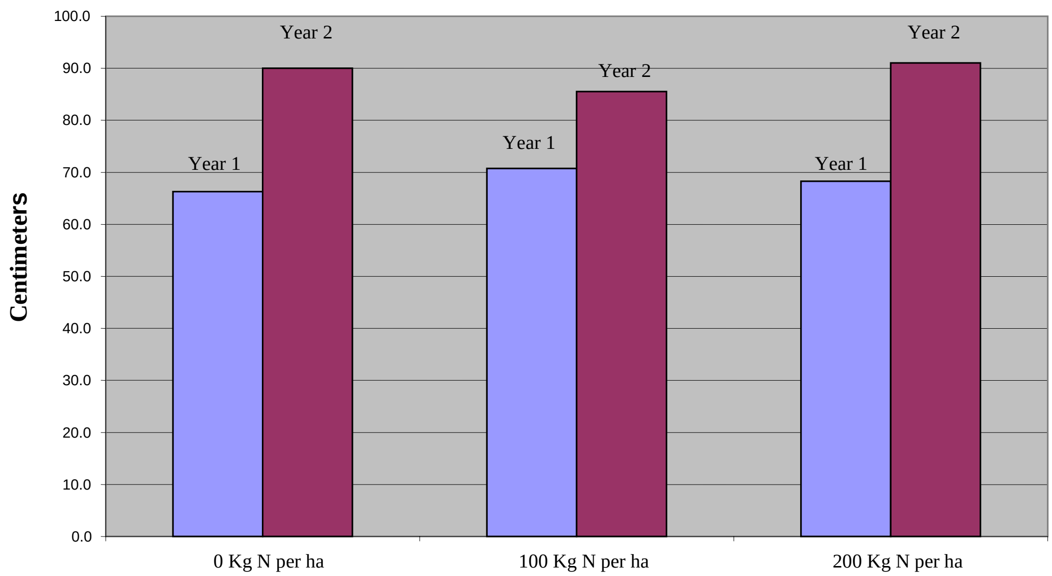

Fig. 3. Interaction (year X nitrogen) affected spike lengths at first florets opening.

Spike lengths (cm) at full spike opening: Years and its interaction with cultivars had a significant effect on spike lengths of gladiolus cultivars at full spike opening (Table 1). Years across cultivars and nitrogen levels, indicated that year 2 plantation produced lengthier spikes (107.9 cm) than the spikes (90.7 cm) produced in year 1 (Table 2). Maximum spike lengths (122.5, 117.3 cm respectively) were observed in cultivars Rose Supreme and Jester Ruffled whereas minimum spike lengths (70.4 cm) were noted in cultivar White Friendship (Table 2).

Cultivars in response to different years showed that cultivar Rose Supreme produced lengthy spikes of 110.2 and 134.8 cm in year 1 and year 2 respectively followed by Jester Ruffled and Deciso that produced 129.7 and 117.2 cm lengthy spikes in year 2 (Table 3). However, cultivar White Friendship remained consistent in producing spikes with almost the same lengths in both of the years (Table 3).

Spike lengths at first florets and full spike opening were similarly affected. But it was observed that interaction between years and nitrogen did not affect spike lengths at full spike opening. These findings pertaining to spike lengths at first florets and full spike opening, opposed the findings of Sidhu & Arora (1989), Chattopadhyay *et al*., (1992), Singh 2000) and Jhon *et al*., (1997) who reported that nitrogen significantly affected spike lengths.

Average number of florets spike^{-1}: Years and their interaction with cultivars had a significant effect on average number of florets spike^{-1} of gladiolus cultivars while nitrogen levels did not have a significant effect on average number of florets spike^{-1} (Table 1). Production of florets spike^{-1}was more (16.4) in year 2 than in year 1 that resulted in 13.7 florets spike^{-1} (Table 2). Cultivar Rose Supreme produced the greatest number of 17.2 florets spike^{-1} whereas cultivar White Friendship produced the smallest number of 11.8 florets spike^{-1}. However, rest of the cultivars remained in between these two cultivars (Table 2).

Cultivars Rose Supreme produced the greatest number (15.5) of florets in year 1 but was second with 18.9 florets spike^{-1}to the highest yielder cultivar Jester Ruffled that produced maximum number of 19.2 florets spike^{-1}in year 2. However, cultivars Jessica and Deciso produced 18.2 and 17.0 florets spike^{-1} when grown in year 2. Moreover, minimum number of 11.9 and 10.8 florets spike^{-1} were noted in cultivars Hong Kong and White Friendship in year 1 and year 2 respectively (Table 3).

Average numbers of florets spike^{-1} were cultivars dependent and hence different numbers of florets spike^{-1} were significantly different among cultivars. These findings are in agreement with the findings with those of Patil *et al*., 1994) and Pant *et al*., (1998) who reported different number of florets spike^{-1}.

Production of florets spike^{-1} was more (16.4) in year 2 than in year 1 that resulted in 13.7 florets spike^{-1}. This might be due to the prevailing environmental conditions in both years. Florets spike^{-1} was significantly affected by the interaction of genetic make-up and environment and thus it was observed that certain cultivars produced maximum number of florets in year 1 and the same cultivar was surpassed by the other ones in year 2. For example cultivar Rose Supreme produced maximum number of 15.5 florets in year 1 but it was surpassed by cultivar Jester Ruffled that yielded maximum number of 19.2 florets in year 2. Besides, nitrogen did not have a significant effect on number of florets spike^{-1} and it confirmed the findings of Pandey *et al*., (2000) who reported that nitrogen had no significant effect on number of florets spike^{-1}. Moreover, this finding is not in conformity with those of Chattopadhyay *et al*., (1992), Jhon *et al*., (1997) and Mukherjee *et al*., (1994) who found that nitrogen application significantly enhanced number of florets spike^{-1}.

Average number of spikes corm^{-1}: Average number of spikes corm^{-1} of gladiolus cultivars was significantly affected by interaction between cultivars and years (Table 1). Maximum number of 1.4 spikes corm^{-1} was observed in cultivar Jessica while minimum number of 0.4 spikes corm^{-1} was noted in cultivar Hong Kong (Table 2).

Besides, cultivars Jessica and Jester Ruffled produced greater number of 2.0 and 1.6 spikes corm^{-1} in year 1 and year 2 respectively followed by Rose Supreme that yielded 1.5 spikes corm^{-1}. However, minimum number of 0.4 and 0.3 spikes corm^{-1} were observed in cultivars Hong Kong and Madonna in year 1 and year 2 respectively (Table 3). This characteristic is seemed to be genotype, and its interaction with environment dependent. Therefore significantly different number of spikes corm^{-1} was observed in various cultivars and in different years.

First florets persistence (in days): Years had a significant effect on the persistence of first florets of gladiolus cultivars (Table 4). Comparison of the two years indicated that first florets remained fresh for longer period of time (7.1 days) in year 2 (Table 5). First florets persisted for a longer period of time (8.0 days) in cultivar Rose Supreme whereas rest of the cultivars remained the same as far as first florets persistence was concerned. Nevertheless, Jester Ruffled and Madonna retained their florets fresh for shorter period of 5.9 days (Table 5).

Last floret persistence (in days): Years and interactions (years X nitrogen levels, years X nitrogen levels X cultivars) significantly affected last florets persistency in gladiolus cultivars (Table 4). Last florets persisted for more days (4.9 days) in year 1 than in year 2 (4.5 days) (Table 5). A specific trend that last florets persistency was decreased with an increase in nitrogen levels was observed in year 1 while there was no specific trend in year 2 but an increase in last florets persistency was observed at 0 and 200 kg N ha^{-1} (Fig. 4).

Table 4. Results of ANOVA on first and last florets persistence (FFP, LFP respectively) in days, average number of daughter corms and cormels per mother corm (DC M^{-1}C, cormels M^{-1}C respectively), average diameter of daughter corms (DDC) and cormels (DC) in cm of gladiolus cultivars fertilized with nitrogen (0, 100 and 200 kg ha^{-1}) during 2003-04 and 2004-05.

Source	DF	FFP (days)	LFP (days)	DC M^{-1}C	Cormels M^{-1}C	DDC (cm)	DC (cm)
Model	59						
Error	84						
Corrected total	143						
Year (Y)	1	**	*	*	NS	NS	NS
Rep (year)	4						
Nitrogen (N)	2	NS	NS	NS	NS	NS	NS
Y X N	2	NS	*	NS	NS	NS	NS
Rep (Y X N)	8						
Cultivar (C)	7	*	*	**	**	**	**
Y X C	7	NS	NS	**	**	**	**
N X C	14	NS	NS	NS	NS	NS	NS
Y X N X C	14	NS	*	NS	NS	NS	NS

NS = *, ** Non-significant or Significant at p<0.05 or 0.01, respectively

Table 5. Effect of years (2003-04 and 2004-05) on FFP, LFP, DC M^{-1}C, cormels M^{-1}C, DDC and DC of gladiolus cultivars.

Source	FFP (days)	LFP (days)	DC M^{-1}C	Cormels M^{-1}C	DDC (cm)	DC (cm)
Years						
Year 1 (2003-4)	6.0	4.9	1.4	31.4	6.2	1.4
Year 2 (2004-5)	7.1	4.5	1.3	34.2	6.4	1.5
Cultivars						
Deciso	6.7	4.1	1.3	22.2	6.0	1.3
Hong Kong	6.0	4.6	0.9	12.8	5.9	1.7
Jessica	6.9	5.2	1.6	11.3	5.7	1.4
Jester ruffled	5.9	5.0	1.3	7.3	6.4	1.3
Madonna	5.9	5.3	1.4	11.5	5.7	1.0
Peters pears	7.0	4.2	1.6	18.9	7.0	1.6
Rose supreme	8.0	5.0	1.4	138.8	7.8	1.7
White friendship	6.3	4.2	1.5	39.4	6.0	1.5

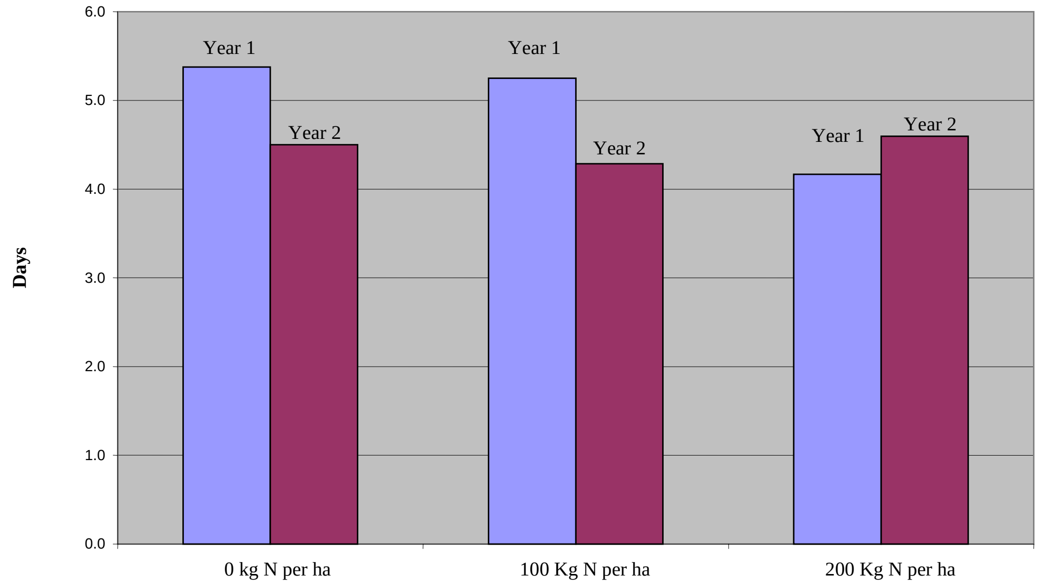

Fig. 4. Interaction (year X nitrogen) affected last florets persistence.

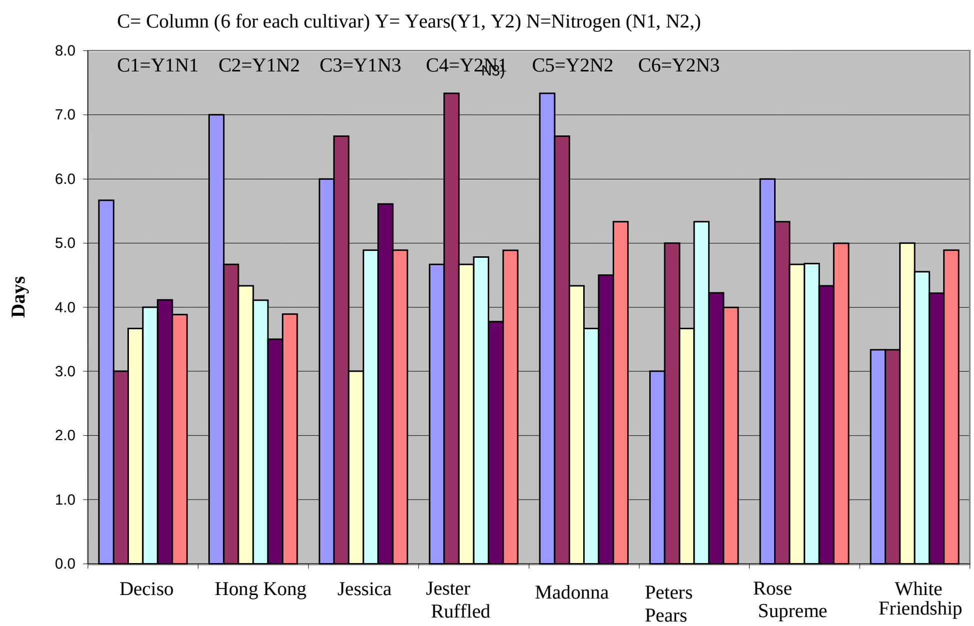

Fig. 5. Interaction (year X nitrogen X cultivar) affected last florets persistence.

Cultivars Madonna and Jessica retained their last florets fresh for an average number of 5.3 and 5.2 days whereas cultivar Deciso retained its last florets fresh for a shorter period of 4.1 days (Table 5). Interaction among years, nitrogen levels and cultivars, showed fluctuations in the response of cultivars to different levels of nitrogen applied in both years. Last florets were remained fresh for longer period in cultivars Deciso, Hong Kong, Madonna and Rose Supreme fertilized with no nitrogen in year 1. However, cultivars Jessica and Jester Ruffled retained their last florets fresh when fertilized with 100 kg N ha^{-1} in year 1. Besides, an increase in nitrogen levels reduced last florets persistency in Hong Kong, Madonna and Rose Supreme in year 1 whereas the persistency of last florets of Peters Pears and Madonna was decreased and increased respectively with an increase in nitrogen levels applied in year 2 (Fig. 5).

First and last florets remained fresh for longer period of time in year 2 and year 1 respectively. First and last florets persistency were found significantly different in different cultivars. It was also observed that maximum first florets persistency was noted in cultivars other than those where last florets persistency was more. It indicates that this is not essential for a cultivar to have maximum persistency in both types of florets. However, it was crystal clear that first florets remained fresh for longer than last florets. This is due to the fact that the energy and food material were already utilized by the florets lower than the last florets which opened first and senesced earlier. Last florets persistency was decreased with an increase in nitrogen levels in year 1 while there was no specific trend in year 2. This might be due to more rainfall in year 2 as compared to year 1 that might have disturbed the effect of nitrogen.

Average number of daughter corms mother^{-1} corm: Years and their interaction with cultivars had a significant effect on average number of daughter corms mother^{-1} corm of gladiolus cultivars (Table 4).

Production of daughter corms mother^{-1} corm was more (1.4) in year 1 than the number (1.3) of daughter corms mother^{-1} corm produced in year 2 (Table 5). Cultivars Jessica and Peters Pears irrespective of nitrogen levels and years produced maximum number of daughter corms (1.6) followed by White Friendship, Madonna and Rose Supreme that produced 1.5, 1.4 and 1.4 daughter corms mother^{-1} corm respectively. However, cultivar Hong Kong produced minimum number of 0.9 daughter corms mother^{-1} corm (Table 5). Interaction between years and cultivars showed that cultivars Jessica and Madonna produced maximum number of 2.2 and 2.0 daughter corms mother^{-1} corm in year 1 respectively followed by White Friendship that yielded 1.7 daughter corms mother^{-1} corm. However, minimum numbers (0.8) of daughter corms mother^{-1} corm were noted in cultivars Hong Kong and Madonna grown in year 2 (Table 6).

Table 6. Effect of interaction on FFP, LFP, DC M^{-1}C, cormels M^{-1}C, DDC and DC of gladiolus cultivars fertilized with nitrogen (0, 100 and 200 kg ha^{-1}) during 2003-04 and 2004-05.

Year	x	Cultivars	FFP (days)	LFP (days)	DC M^{-1}C	Cormels M^{-1}C	DDC (cm)	DC (cm)
2003-04	x	Deciso	6.6	4.1	1.3	32.3	5.9	1.2
		Hong Kong	6.8	5.3	1.0	16.2	6.6	2.3
		Jessica	6.1	5.2	2.2	11.0	5.7	1.5
		Jester ruffled	4.8	5.6	1.0	4.7	6.6	1.2
		Madonna	5.1	6.1	2.0	17.8	5.9	1.0
		Peters pears	5.6	3.9	1.3	12.5	6.5	1.6
		Rose supreme	7.3	5.3	1.1	93.6	6.9	1.5
		White friendship	6.1	3.9	1.7	62.7	5.6	1.3
2004-05	x	Deciso	6.9	4.0	1.3	12.1	6.1	1.3
		Hong Kong	5.2	3.8	0.8	9.4	5.3	1.1
		Jessica	7.6	5.1	1.1	11.6	5.7	1.4
		Jester ruffled	7.0	4.5	1.6	9.9	6.2	1.4
		Madonna	6.7	4.5	0.8	5.3	5.5	1.1
		Peters pears	8.4	4.5	1.8	25.4	7.5	1.7
		Rose supreme	8.7	4.7	1.8	184.1	8.7	1.9
		White friendship	6.6	4.5	1.3	16.1	6.5	1.8

Average number of cormels mother^{-1} corm: Interaction between years and cultivars had a significant effect on average number of cormels mother^{-1} corm of gladiolus cultivars (Table 4). Cultivar Rose Supreme produced the greatest number of 138.8 cormels mother^{-1} corm whereas cultivar Jester Ruffled produced minimum number of 7.3 cormels mother^{-1} corm (Table 5). Cultivar Rose Supreme proved consistent as higher yielder and produced maximum number of 93.6 and 184.1 mother^{-1} corm in year 1 and year 2 respectively. However, cultivars Jester Ruffled and Madonna produced minimum number of 4.7 and 5.3 cormels mother^{-1} corm in year 1 and year 2 respectively (Table 6).

It was observed that the daughter corms and cormels mother^{-1} corm yielded by cultivars were significantly different. It might be due to their genetic capability of producing different number of daughter corms and cormels mother^{-1} corm. Besides, there was an interaction (years X cultivars) against number of daughter corms and cormels mother^{-1} corm. This might be due to the different environmental conditions existed in both years, different genotypes and also their interaction with the environment. These results are in agreement with the findings of Vinceljak (1990) who reported maximum production in the first year of two years experiment. These findings are in agreement with the findings with those of Patil *et al.*, 1994), Aswath & Parthasarathy (1996) and Pant *et al.*, (1998) who reported different number of corms or cormels per mother corm.

Average diameter (in cm) of daughter corms: Interaction between years and cultivars had a significant effect on average diameter of daughter corms of gladiolus cultivars (Table 4). Cultivar Rose Supreme produced the biggest daughter corms with an average diameter of 7.8 cm whereas the smallest daughter corms with an average diameter of 5.7 cm were produced by cultivars Jessica and Madonna. Rest of the cultivars remained in between these cultivars (Table 5).

Cultivar Rose Supreme produced maximum size of daughter corms in both years with an average values of 6.9 and 8.7 cm whereas cultivars White Friendship and Hong Kong produced minimum size of 5.6 and 5.3 cm daughter corms in year 1 and year 2 respectively (Table 6).

Average diameter (cm) of cormels: Interaction between years and cultivars had a significant effect on average diameter of cormels of gladiolus cultivars (Table 4). Cultivars Hong Kong and Rose Supreme produced cormels with maximum size of 1.7 cm while cultivar Madonna produced cormels with minimum size of 1.0 cm (Table 5). Interaction between years and cultivars showed that cultivars Hong Kong and Rose Supreme produced maximum size of cormels (2.3 and 1.9 cm) in year 1 and year 2 respectively (Table 6). Cultivar Rose Supreme produced the biggest daughter corms and cormels while Hong Kong produced cormels of the same size as Rose Supreme. It might be due to the genotypic capabilities of producing corms and cormels with different sizes. A significant interaction between years and cultivars was observed as far as diameter of daughter corms and cormels are concerned.

Conclusion and Recommendations

It is concluded that most of the characteristics of gladiolus were significantly affected by the environment prevailed during both years. Nitrogen did not show significant effect for most of the characteristics and it affected significantly days to full spike opening, plant height and first florets size at color showing. It was also concluded that nitrogen applied in different years affected significantly days to full spike opening, plants corm^{-1}, first florets size, spike lengths at first florets opening and last floret persistency. All cultivars were significantly different for characters studied during the project. Furthermore, cultivars performed differently in different years and yielded significantly different results for all growth and yield parameters except persistency of first and last florets. Cultivars did not respond to nitrogen levels significantly for most of the characteristics except days to full spike opening. Days to spike emergence and full spike opening, plant height and last florets persistency were significantly affected by the application of nitrogen to different cultivars in different years.

It is recommended that different cultivars will be grown in different environments where they perform well. But it is recommended that a mixture of certain cultivars should be grown for satisfying the demands of the customers and to have steady supply to the market. Cultivars Rose Supreme proved superior followed by Jessica, Jester Ruffled, Deciso and Peters Pears under the soil and environmental conditions of Peshawar and hence recommended for the area. Nitrogen is recommended for gladiolus when it is grown for commercial cultivation.

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(Received for publication 3 October 2011)